DING
MATOR

The Building Estimator

BY

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OMAHA, NEB.

Box 482

Cloth, $1.50

PREFACE.

We sometimes hear of books being sent from publisher to publisher for weary months and being at last rejected. This one was never sent from home. For what seemed good reasons I concluded to publish it myself.

The illustrations are mostly taken from local sources, but I have had a wide enough experience to draw a fair average of time required on all kinds of work. In addition to an apprenticeship on the other side of the Atlantic, and another apprenticeship as a contractor in the West, I spent three years in the city of New York, and half as long in each of the western capitals—Chicago and St. Louis. This much to satisfy those who read the preface that the book was not compiled by a theorist. No matter where work is done, if it is done right there is not such a great amount of difference in the time required.

For the last three years I have been in the Chief Engineer's office of the Union Pacific Railroad making plans and estimates for shops, etc. The old saying runs, "If you want to find out how little you know of a subject, write about it." No one can be more sensible than I of how far this comes short of being an ideal book, and yet it is much better than it would have been had the railroad experience not been added to the total, as that showed larger quantities handled on another class of work than falls to the average contractor.

Doctor Johnson, the dictionary man, used to pride himself on his prefaces, for in them he explained how a book should be written, and why it was impossible so to write it. The Engineering News in a recent complaint over the dearth of technical books written by practical men forgot to mention, among other reasons for the deficiency, that the perspective looks so much better than the building as to induce a feeling of discouragement. And yet, it is better that it is so; for all men and railroads, all arts and sciences, and most books, like trees, must grow or rot. If, therefore, while there is much here that is not elsewhere, you meet the common fault of such works—a lack of something that ought to be shown in capital letters—it is to be regarded not so much as a blemish, as a sign that progress is still possible, and as a flattering invitation to try your skill as an author and make two words grow where only one grew before.

We are great believers in advertising here, but I read the other day in an interesting book, "Of one thing there can be no doubt whatever—for one volume sold in consequence of a newspaper advertisement, a thousand are sold by casual mention on the part of appreciative readers." While advertising is undoubtedly good, a personal recommendation carries more weight, and those who find this book of use will know their duty—Pass it along. The more a gold mine is worked the poorer it becomes: the more a book of this kind is worked and added to and corrected the richer is the return for everybody. A reasonable critic is a public benefactor.

Omaha, Nebraska, U. S. A.,
June 25, 1904.

SECOND EDITION.

The Index of the first edition was deficient, and an entirely new one is now presented. The matter from page 150 to the end is also new. By leading the work it would have had about fifty more pages with the same matter, but technical books are not valued for size or weight. My thanks are due to all who bought the first edition of the Building Estimator, and especially to those among them who recommended it to others. Oct. 1905.

TABLE OF CONTENTS.

ABBREVIATIONS.

bm board measure
cf cubic foot or feet
ci cubic inch or inches
cy cubic yard or yards
col column
diam diameter
d and m dressed and matched
d m and b dressed, matched and beaded
ex expanded
fob free on board
lf lineal foot or feet

M 1000
m measure
mult multiply or -plied
O G, P G styles of door moldings
ps piece
pcs pieces
q s quarter-sawed
s g straight-grained
surf surface
sq square, squares, 100 sq ft
V G vertical-grained
wp white pine
yp yellow pine
' " feet and inches

INDEX.

[1] Immanuel Hospital, Omaha.

[2] Fire-Proof Wing to State Hospital, Lincoln.

No. 3

McCague Building, Omaha

No. 4

Electric Light Building, Omaha

Manderson Block, Omaha

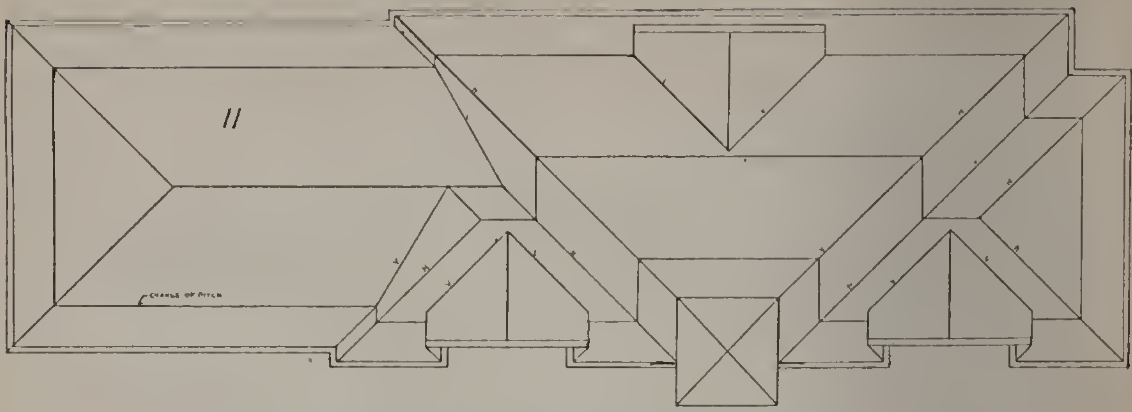
Harris and Fisher Blocks, Omaha

U. P. R. R. Machine Shop, Omaha, 1902

O. S. L. Machine-, Boiler- and Blacksmith Shop, Pocatello, Ida., 1902

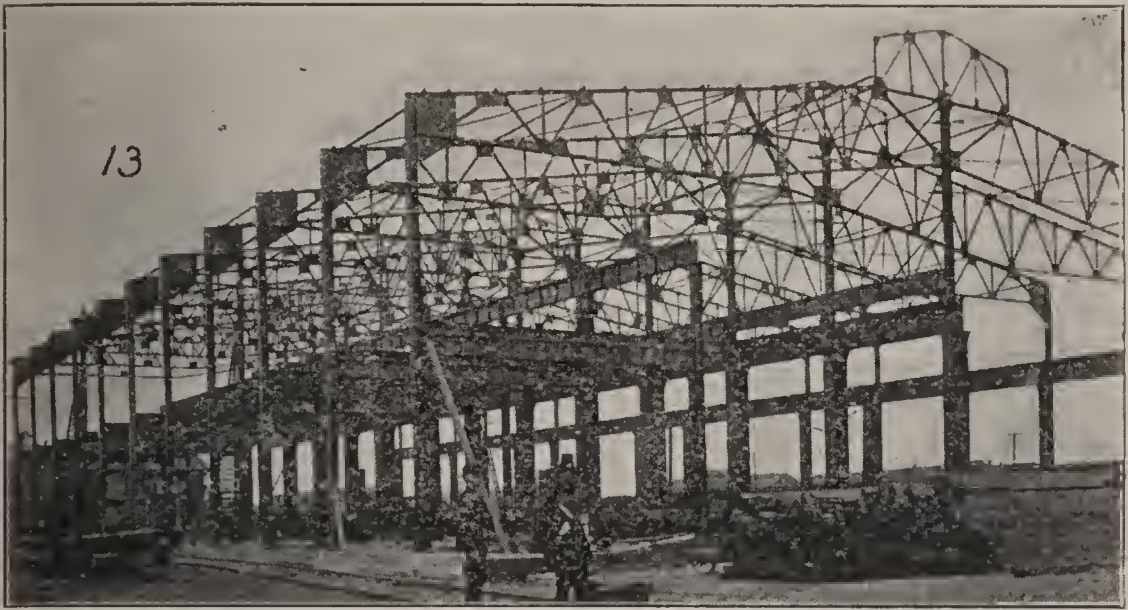
Presbyterian Seminary, Omaha

Block of Flats, Omaha



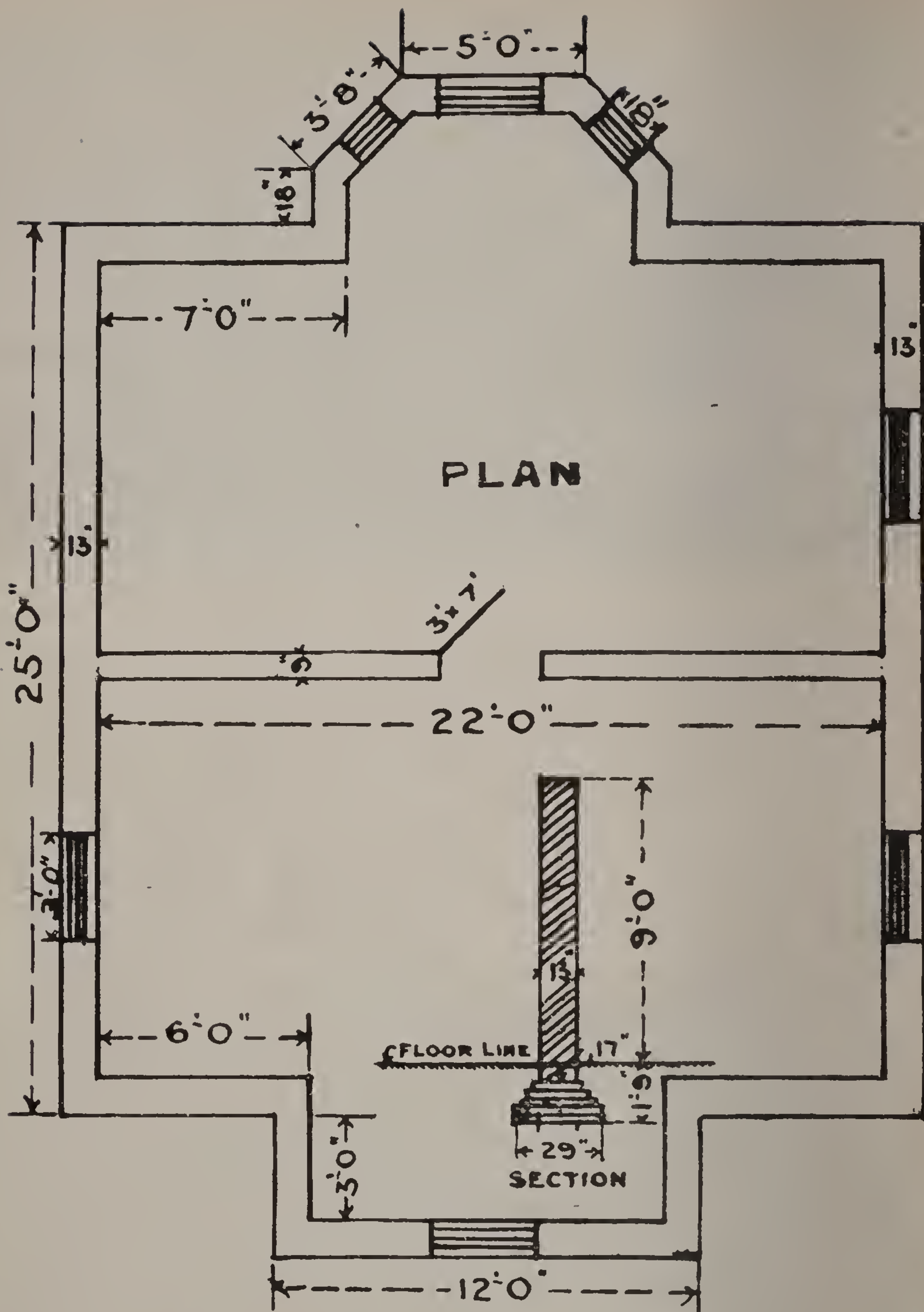
Roof of Passenger Station.

Bancroft School, Omaha



Half of Steel Framework of No. 7

Part of Steel Framework of U. P. R. R. Boiler Shop



MEASUREMENT OF BRICKWORK.

With all plans symmetry is understood unless otherwise stated: this plan is symmetrical. Footings are 15″ high—2 bottom courses 29″, top course 17″; walls above, 9′ 6″. Windows are 6′ high, and all openings are deducted. Number of brick above footings, 23,761; in footings, 7,000: total in *wall measure,* 30,761. See Chap 5 for method of obtaining result.

INTRODUCTORY.

"For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it? Lest haply, after he hath laid the foundation, and is not able to finish it, all that behold it begin to mock him, saying, This man began to build and was not able to finish."

"The house is never built for less than the builder counted on."
"The Cloister and the Hearth."

This is an age of machinery, and "The Building Estimator" is put forth as another labor-saving machine.

A book of this kind is necessary for estimators and contractors as much as special books are for men in other callings. It is impossible to remember everything—hard to keep many figures in the mind without an occasional reference to tabulated results gained from experience. It would be better to say average experience, for I once asked three brick contractors how much lime was required for a thousand brick, and the first said half a barrel, the next a barrel and a half, and the last a barrel. They did their work close to the supply yards and probably had never taken the pains to get accurate figures, or they perhaps believed in different proportions of sand.

About two years ago I wanted more precise information than I possessed on certain points, but I did not want to compile it myself. Willing to profit by the labor of others I looked into the estimating parts of several standard books, such as Trautwine's and Kidder's, only to find that they had too little space devoted to this branch for my particular purpose, and too much to what did not concern me. Then I procured half a dozen other books, and after examining them concluded that with patience I could, for my own requirements, at least, do better than had yet been done.

I had had a little too much experience to be satisfied with what was presented by several writers who have worked in this field. Before then $7,000,000 of estimates and bids had passed through my hands, and $500,000 worth of completed buildings,—and since then I have made estimates amounting to $3,000,000 or $4,000,000. Only on one—a $40,000 building—had there been any loss, and that of not more than two or three hundred dollars, owing chiefly to considerations apart from estimating. On all others the profit was always at least a little more than was estimated. The same caution displayed in buying real estate would have been of advantage.

Of what use then is such a book as this to an estimator who has certainly had a fair amount of experience in working without one? Much in every way. It saves time, it saves the memory, it gives certainty in-

stead of guesswork,—for what has been once done can be done again,—it preserves the old and gathers the new. There are many new things under the sun for each succeeding generation. It is better to keep a record than to lose the old that is useful or the new that we continually meet and welcome.

Doctors and bricklayers are not the only ones who disagree. Some years ago I was estimating a large warehouse in Omaha. There was a floor of a special kind used. I met a few experienced contractors who were not estimating on the work, and asked them how much it was worth per square. The first figure was $1.50, the second $3, and the third $4. I felt safe at $3, and have since found that the half would have been sufficient. I feel sure that the labor figures will be of value to the old contractor as well as to the beginner; and something will be found that the wisest does not know, for no man knows everything.

When a friend asked Dr. Johnson how he came to define "pastern" in a wrong way, he bravely answered: "Sheer ignorance, sir." I am convinced that many low bids arise as much from sheer ignorance as from any desire to prove in the face of common experience that two and two equal five.

There are likely to be some mistakes in "The Building Estimator," and he who seeks shall find. I have estimated and corrected all by myself, and one misses what two see. I had no idea when I began to hunt through estimate books and labor reports years old that there would be so much work connected with the task I had laid down, or it is likely that I should have let it pass to a more earnest brother.

There has been one consolation throughout the work, at all events: In past years I used to get vexed like other contractors at so much figuring with so little result, so many bids with so few contracts, so much cry and so little wool, but that kind of a preparation was of advantage for this work, and I felt it as I plowed along.

"The Building Estimator" will be of value in several ways besides those mentioned:

1:—It will give weights and measures we understand. We live in a new century, and we have new names; the West is not the East, and some of the measures we use are different from those adhered to in other sections of the country. I do not know what a "toise" is, and neither do nine-tenths of our builders. We do not buy or measure sand by the "cask," but by the car or yard; and we have finally and forevermore taken leave of the cord and the perch. I have heard of a contractor who was not any too well pleased when he found that the perch he thought he bought for a large contract and the one he received were not quite the same. We use the cubic foot or yard. Some day when we become really progressive we shall turn to the metric system.

2:—Only a few years ago there were no stone molders. A straight molded sill cost from four to fifteen times as much as a plain one. Now with the aid of the machine the difference is largely done away with. Then the estimator had to be cautious about taking work by the cubic foot; now, if it is straight, that is the most reasonable way to estimate it. The books of the last century still have the old figures and rules.

3:—In the 19th century lime plaster was fashionable; now cement takes the place of lime. I met a plasterer the other day, and he told me that for the first time in nine years he was plastering a small building with the old brand. The tables for allowances in the standard books have not a word to say about the quantities for cement plaster, and the allowances in this book deal chiefly with the new kind.

The astonishing developments in metal lath, expanded metal and concrete, have turned our old figures and ideas upside down. The walls of immense manufacturing buildings are now put up only two or three inches thick. It is time to recognize this new method of construction in a new book. It is a matter of regret that so little can be said on the subject, but a beginning being made here, more information will come from those who are interested in this work, and well acquainted with it.

When the walls are up they are covered with cold-water paint, put on with compressed air with either steam or hand power behind it. Our grandfathers never heard of this paint and this brush.

4:—After all the inevitable corrections are made "The Building Estimator" may serve as a kind of a standard. Those who refer to it will not, of course, bring in bids varying only one or two per cent, but the present differences ought to be done away with. They are sometimes large enough to make one wonder if all contractors use the same multiplication table. Occasionally, however, there are factors that enter into a complete bid and make a larger difference than seems warranted by the price of material and labor. There are often cases where B is sure that C, the successful contractor, is going to lose money, while C has a subbid or a favorable price of material that keeps him safe. Or again, C may know a better way of doing the work.

With experienced contractors, one would think, bids ought to come within five per cent of difference, but they sometimes stretch to thirty, and on new kinds of work even to fifty. I recently saw something akin to what every contractor sees many times in the course of a year: on some plain millwork that I had estimated at $3,400, the bids from men who did nothing else than supply this material ranged from $3,100 to $4,800. The highest wanted half as much again as the lowest. One mill might have plenty of work and put in a high figure; another might be short of work and cut prices. When this happens with millmen who spend their lives at one specialty what can be expected from general contractors who sometimes estimate a complete building themselves? On a U. S. contract let in Omaha in 1903 the lowest bid was $376,000, and the highest $490,000, and both bidders were experienced contractors.

And while we desire to see greater uniformity it is well to remember that it is not only actual cost which affects the result, but the percentage added for risk and profit. Three per cent on $100,000 makes a total of $103,000; ten, $110,000; and twenty-five,—which I have seen recommended by a kind-hearted parlor estimator—$125,000.

But again the two lowest bids sometimes come surprisingly near each other. On No. 3 the contractor whose bid was next to our ac-

cepted one, came within $400 of $125,000; on the Omaha Public Library—running about $60,000, I think—we came next to him, but about $350 higher. It is like gambling—and thus it is that the contracting habit once formed seldom releases a man until it lands him in the poorhouse or the penitentiary.

And as a final word on uniform bids, unreliable estimates, and so forth, it is often necessary to look at the date when they were made. Prices sometimes soar high or fall low in a month or even less. An architect or contractor can not control markets, monopolies, or unions.

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Perhaps I should say a few words as to how estimating is done and trouble avoided. It might be as well to pass on without doing so, as experience is the best teacher, but some counsel may be ventured:

A:—In the first place there is no such thing as time in proportion to cost in estimating. On some buildings an estimator might spend three or four days in figuring millwork alone, and on others a few hours might be sufficient; while $1,000 of hardware might take as long as ten times that amount of plain brickwork. Examine a plan before you promise an architect to take it back with your bid in seven hours and a quarter. Do not risk your money on too fast a gait.

B:—In making up an estimate it is better and safer to keep each factor of a complete bid separate, to finish and double-line it, and to make a summary of all the items at the end. By this method any error or change in plan,—in brickwork, suppose,—can be added under its proper heading without affecting plaster or hardware; while if the total is carried from page to page it is impossible to change a figure without making a risky change necessary clear through.

And the same system should be followed under all subheadings. Suppose, for example, that there are twenty to forty different items of concrete in a foundation: If the whole amount is set down as so many cy there is no way of making a separation in case of a change. If a change is made the whole laborious work has to be gone over again; while if set down in detail probably three-fourths of the figures have only to be copied.

C:—Get the exact cost and add whatever profits you think possible. You will not get anything extra in these latter days. Some contractors add the profit on each article as they go along and can never tell exactly what they have apart from the cost. It is not a good practice.

D:—"Order is heaven's first law." As far as possible make out an estimate in its natural order. Some specifications put on the finials before the rafters are in place. Excavation usually comes first and painting or shelf hardware last.

E:—Make out your estimates in a book and keep it, and correct "The Building Estimator" or any other estimator by your own experience. "Keep a thing seven years and you are sure to find a use for it." It may be that the building burns and the owner needs your help, or that you want to buy it with your surplus profits, or that you are even elected assessor.

Keep a record of time on each building and make comparisons. Why should the labor on one building take ten to forty per cent more time than that of another?

F:—It is, of course, a matter of choice, but I never like to hear a bid read out for $40,000.11. I always think that for mere good luck the few cents ought to be given the owner. Estimating is not an exact science like mathematics. In general I prefer to add or deduct either two or three cents if necessary so that the cent column will end in 0 or 5. By the time the end is reached a fair average is made, and this method makes the adding easier.

G:—In making an approximate estimate for an owner or architect be liberal. There are forty different ways of increasing the cost of a building by the addition of a few words to the specifications. Brick properly shoved means fifty cents a thousand extra. It is seldom properly shoved although specified. A change to a better pressed brick may be worth $10 or $20 a thousand. Cement is more expensive than lime, and Portland cement is more expensive than natural. Hardwood finish costs more than cypress, and oil finish rubbed down costs more than two coats of cheap paint.

H:—Do not be afraid of an extra. It has its advantages. Architects do not, as a rule, like extras, and owners who order them groan when the bill is presented, but why should they? If they go to a store to buy a shirt do they feel sulky because they have to pay for the necktie that takes their fancy? The proper way is to settle for an extra before a tool is lifted, but whether this is done or another method followed the matter ought to be cleared up at the end of each month. "Short accounts make long friends."

Any architect who is worth houseroom will give a written order for an extra so that the contractor may have authority to expend money which he does not pick up in the street. If the architect asserts that the work belongs to the original contract the time to settle the matter is when both parties are familiar with the conditions.

It is rather a risky thing to sign a contract which gives one party the sole right to settle all disputes. On No. 2 I did so and regretted it. I objected strongly to the contract presented but was told that the state had "suffered" in the past, etc. The state of Nebraska has deserved to suffer.

If possible use the "Uniform Contract." It may be safely signed without examination. For many years it has been under the eyes of builders, architects and lawyers in all sections of the country, and the general conclusion is that for contractors and owners alike it is the best contract ever devised. Of course, if an owner has the power he will use another and more one-sided instrument. That is human nature.

I:—Get subbids made out "according to plans and specifications," and do not accept a list. Material men and subcontractors are sometimes a little unreasonable. A general contractor has to take chances of all mistakes, while a subcontractor in following the list method refuses to take chances on even his small proportion.

J:—If you are so fortunate as to proceed from estimating to construction insure against fire, lightning, and accident to person or building. "Then," you say, "the insurance men would get all the profits and we would get left." It is a sad state of affairs, but can you risk losing all you have? Suppose two or three men are killed? Suppose a fire gets the upper hand? Most Omaha contractors remember a firm that finished a schoolhouse ready to turn over. Their insurance lapsed and the building was destroyed by fire before it was accepted. That ended their career in the building line. Another Omaha contractor with lapsed insurance had to pay $1,300 for a fatal accident. On No. 5 one partition was burned out, and the building might easily have followed. On No. 3 a man was killed. It is far too dangerous to risk fire loss and damage suits without insurance.

K:—Do not accept any contract where the reserve is more than 15%, unless you have plenty of money,—and if you have why be a contractor? Do not give a bond for more than one-third of the contract, and fight for one-fourth, which is enough. If the owner is afraid of a 10% reserve and a bond for even one-fifth, he ought to hunt up another contractor, for he is clearly dealing with the wrong man.

It is but right that a contractor should be paid for material delivered on the ground. The state of Nebraska does this, and so does the United States. But a contractor, no matter what his financial standing, should be obliged to show receipts for material embraced under his previous payment before another is given, or else show a waiver from his material men. Wages in cities are paid on the building, and the owner or his representative may see to this for himself, so that there will not be any danger of liens. Personally I never lost even a single dollar through an owner, and no material man or subcontractor ever lost one through work done for me, but trouble of that kind sometimes comes like lightning. A certain amount of capital is necessary. Do not attempt to bite off more than you can chew.

L:—Finally, my brethren, if you really put your foot in it, back out. It is rather an unpleasant thing to do, and I have had to do it only once when the carpenter labor was carefully estimated and not put in the total. But it is sometimes better to sacrifice pride than dollars. Most blunders are caught in time—but some are not caught until too late a time. The best will make a mistake—but do not get scared into the backing-out habit.

We have all heard tales of woe without number,—cornices forgotten, roofs left off, cut stone omitted, and so on to the end of the dismal chapter. Add a percentage. It is unsafe to be without it. A percentage is an excellent thing to have around a finished house, or one that merely shines on paper. They all say so, but the trouble is that when the percentage is added in its proper place, some one who forgot it gets the contract. Two of the parlor estimators' books which I sighed over, say that it should never be less than 5% and never more than 25 or 30%: 10 is said to be fair. Well, rather. Fair to middlin', most contractors would say. On a general contract 5% is luxury now.

Architects will find valuable information in "The Building Estima-

tor," but the book is chiefly designed for estimating and need not be examined for much else. An estimator needs a book of his own. When one considers the variety of buildings, ranging in the west from three-roomed cottages to five- and ten-story fire-proof structures, and that a general contractor has to have a fair acquaintance with each branch, there seems to be quite enough in this field to engage the attention of any one man. "How much will it cost?" is an important question that has to be decided before the final word is given to go ahead. And herein lies the responsibility of the estimator. He must do his work carefully enough to keep his employer out of the bankruptcy court. An owner is sometimes swamped with a heavy bill of extras.

I thought it a good idea to give pictures of some of the buildings from which my figures have been drawn. In a book of this kind an illustration is worth many pages of writing, and yet curiously enough I never saw one of the right kind in the books I looked through. When actual results are given on typical buildings a raw estimator can proceed with confidence.

Figures are used in all cases. In technical works this is a better system than spelling out words which remain half buried in the page instead of standing out clear. Those who do not like the system of compounding words can lay the blame on the "Standard Dictionary," the latest American authority.

No allowance is made for profit: actual cost is given straight through unless otherwise stated. In measurement actual quantities only are taken: trade rules for doubling corners, including openings, taking attic plaster on the square, etc., are not recognized in this book; but brickwork is allowed in "wall measure," or 22½ bricks to the cf.

"The Building Estimator" is only a fair beginning, and not so good as it may become. But I feel certain that with this fair beginning manufacturers, contractors, engineers and architects will contribute useful data, and in time the best book of the kind will be at our service. Mechanical engineers have Kent, civil engineers have Trautwine, architects find Kidder useful, and it is time that contractors had a book of their own, although I never wish to see theirs more than half as large as those mentioned. If properly nurtured this one will grow and become more valuable just as the others grew in size and wisdom.

PART 1

APPROXIMATE ESTIMATING

EXCAVATION

Excavation may cost all the way from 15c to $1 per cy, according to the wages paid, the thermometer, the character of the soil, length of the haul and other local conditions. We have but little rock in Nebraska, and 25c may be taken as an average price.

PILING

From 30c to 35c per lf, driven and cut.

CONCRETE

Ordinary concrete with natural cement, such as Milwaukee or Louisville, at $1.10 a barrel, $4.60 per cy. With American Portland at $2.50, $6. If there is no hauling or unloading deduct 20c per cy.

RUBBLE

From $4.75 to $6 per cy depending upon the character and amount of the work.

CUT STONE

Bedford is a standard here. For a building with a fair allowance of straight moldings, $1.50 per cf all through. If carving is used each piece must be priced separately. For water-table, sills and plain work, $1.40. On a large bill add 10 to 15% for setting.

BRICKWORK

As this first part of the book may be used by those who are not accustomed to the trade method of estimating, the following rule is given, but it must be remembered that although walls are marked 13″ they count as 12″: Find the cf after deducting all openings, and then mult by 22½ for the number of brick, and mult the product by the price of the brick per 1,000 laid down on the ground, plus $3 for labor and mortar. Thus brick delivered at $6.50 would be estimated at $9.50. Hard brick for work below ground are a trifle smaller and cost about 50c per 1,000 extra. If work is laid in cement, add 75c per 1,000 wall measure.

The foregoing rule applies to common work. On buildings with pilasters, offsets, cornices, etc, an extra allowance must be made according to judgment. On a building on South 13th Street, Omaha, a bricklayer who has now left us paid $1,800 for a lesson in laying a "gingerbread" front, and a few more thousands for another lesson in a mud-hole 20 feet below grade.

If pressed brick are used get the exact number of sq ft and mult by 7. Mult the result thus obtained by the price per 1,000 delivered, and add to former estimate without deducting any common brick. The price of the pressed brick is thus added to make up for the extra time spent in laying. On some fine fronts another extra allowance of from $10 to $20 per 1,000 is made.

STEEL & IRON

Put steel beams at $80 to $90 a ton set, and plain cast iron at $45 to $60. About 1894 steel beams were set for $40.

CARPENTRY

FLOORS, CEILINGS, AND ROOFS

As a basis of calculation a space 22′x100′ in the clear has been taken, and quantities made out for 22 squares. Different classes of buildings require bills of material that vary according to the number of partitions, stairs, chimneys, elevators, etc., and it is of course impossible to give 1 rule for all, but as an average 7 extra joists have been allowed.

By dividing the quantity by the number of pieces the cost of material and labor for 1 joist can be readily found and additions or deductions made to suit. The shorter lengths required for the tail-joists at stair make up for the double-header.

All joists are estimated 22′ long, not 24; but number of feet is given in bm so that price can be easily changed for shorter or longer lengths, and thus also for increase or decrease of the unit used as a basis. The labor can be regulated in the same way according to the local standard. Thus 2x14 joists, 12″ centers, require 5,544′. At a decrease of $3 per 1,000 the cost is reduced $16.63 on 22 squares, or 75c for a square. So with sheeting or flooring according to price. If labor is 30c instead of 40c, the cost of that item—apart from lumber—will be as 3 to 4 on the number of feet.

In the 4th column of the following tables the cost per sq of *joists only* is given—no sheeting, paper or flooring being allowed. The estimator is thus enabled to cover the bare joists of floors, ceilings or flat roofs to suit any specification by using the prices given.

The usual number of anchors are allowed at sides and ends. As they are figured for a 22′ span the number required for a building of, say, 3 spans would be a trifle less, as strap-anchor at joint would take the place of 2 tees, but this does not materially affect the cost.

BRIDGING:—The number of lf for 2 rows has been given The gain on the bevel makes up for the waste, especially on the narrow spaces. On the different sizes and centers of joists the number of lf runs from 380 to 566′. An average price of 70c per sq has been taken for 2x4; less will do for 1x2.

NAILS:—Sufficient nails at $2.75 a keg have been allowed. Nails and labor are of course more for bridging, sheeting and flooring on narrow spaces, but only an average can be given.

LABOR:—The Omaha standard has been taken—8 hours at 40c an hour—so that the estimate is safe anywhere else in this territory if freight, hauling, etc, are watched. On joists an average of 800′ bm, or $8 per 1,000 has been used for 2 men in a day. They will do much more on lower floors of a building, but this is for approximate estimating and is safe from cellar to roof Sheeting has been put in at 1200 ft; shiplap at 1,000; 6″ flooring at 5 sq; 4″, usually for the top floor, at 3½ sq. Sometimes about twice as much might be laid, depending on the building. Plain maple and oak flooring, 2¼ face at 2½ sq. Does it all mean for a large warehouse or for a dwelling divided into small rooms? A little judgment must be exercised and changes made to suit the building. Some oak floors, for example, cost from $10 to $16 per sq for laying alone, in a fine Omaha house recently built. For

special work of this kind reference must be made to "Detailed Estimating" in Part 2.

In the 5th col of the following table the difference in cost for each dollar of difference in the price of joist lumber alone is given in cents. The highest quantity of bridging is 566 lf, and allowing 2x4 the difference per sq for each dollar may be taken as 2 cents on a basis of $20 lumber.

NUMBER OF PIECES REQUIRED

108 at 12 centers	75 at 18 centers	63 at 22 centers
94 at 14 centers	68 at 20 centers	58 at 24 centers
83 at 16 centers		

QUANTITIES REQUIRED

Sheeting 8″	2550′ bm	Flooring	4″	2850′ bm
Shiplap 8″	2650′ "	"	2x6	5200′ "
Flooring 6″	2650′ "	"	maple	2950′ "

PRICE PER SQ OF JOISTS LAID

Centers	Quantity	Lf Brid'g	Price	Diff	Centers	Quantity	Lf Brid'g	Price	Diff
			2x4 list: Lumber, $20						
12	1584	....	2.05	8	20	998	....	1.28	5
14	1379	....	1.76	7	22	924	....	1.18	5
16	1217	....	1.55	6	24	851	....	1.08	4
18	1100	....	1.40	5					
			2x6 list: Lumber, $20						
12	2376	380	3.05	11	20	1496	380	1.91	7
14	2068	380	2.64	10	22	1386	380	1.77	7
16	1826	380	2.33	9	24	1276	380	1.63	6
18	1650	380	2.10	8					
			2x8 list: Lumber, $20						
12	3168	418	4.03	15	20	1995	390	2.54	9
14	2757	410	3.51	13	22	1848	390	2.36	9
16	2435	400	3.10	11	24	1701	390	2.17	8
18	2200	400	2.80	10					
			2x10 list: Lumber, $21						
12	3960	466	5.22	18	20	2494	410	3.29	12
14	3446	446	4.55	16	22	2310	405	3.05	11
16	3044	430	4.02	14	24	2126	400	2.81	10
18	2750	420	3.63	13					
			2x12 list: Lumber, $21						
12	4752	500	6.27	22	20	2992	426	3.95	14
14	4136	474	5.46	19	22	2772	422	3.66	13
16	3652	450	4.83	17	24	2552	416	3.37	12
18	3300	436	4.35	15					
			2x14 list: Lumber, $23						
12	5544	566	7.82	26	20	3491	450	4.92	16
14	4825	530	6.80	22	22	3234	442	4.56	15
16	4261	488	6.00	20	24	2977	434	4.20	14
18	3850	470	5.43	18					

			3x10 list: Lumber, $23						
12	5940	442	8.37	27	20	3740	396	5.27	17
14	5170	424	7.29	24	22	3465	396	4.89	16
16	4565	406	6.44	21	24	3190	388	4.50	15
18	4125	402	5.82	19					
			3x12 list: Lumber, $23						
12	7128	484	10.05	33	20	4488	410	6.33	21
14	6204	460	8.75	29	22	4158	408	5.86	19
16	5478	438	7.72	25	24	3828	400	5.40	18
18	4950	426	6.98	23					
			3x14 list: Lumber, $23						
12	8316	542	11.72	38	20	5236	440	7.38	24
14	7238	502	10.20	33	22	4851	432	6.84	22
16	6391	476	9.01	29	24	4466	420	6.30	21
18	5775	454	8.14	27					

BASEMENT SLEEPERS:—The joists or sleepers referred to here are those that are laid on the earth, on cinders or on concrete, and staked down or nailed with cleats. The number of feet in a day is given in each size. Stakes are not included as they depend upon the character of the soil and other considerations. In some cases, as when concrete is used, they may not be necessary at all except to hold sleepers in place until it hardens, and 1x2 strips are often sufficient; while in other cases 2x4's driven several ft into the ground would be required. For 4 stakes 2′ long in a width of 22′, allow on 16″ centers 37c per sq for lumber. The labor goes in with the leveling, for it should not be so expensive as when stakes are not used.

There are 2 extra sleepers allowed in the 22 sq. Covering is not included. Only a few nails are required, say 2c per sq.

Number of pcs required: 78 at 16″ centers 37 at 36″ centers
63 at 20″ centers 28 at 48″ centers
53 at 24″ centers

Centers	Quantity	Price per sq	Cents for each $1 of diff in lumber	Centers	Quantity	Price per sq	Cts for each $1 of diff in lumber
		2x4 list: $20 per 1000: 400′ bm per day					
16″	1144	1.89	6	24″	778	1.30	4
20″	924	1.53	5				
			4x4 list: $22; 700′				
16″	2288	3.26	11	24″	1555	2.22	7
20″	1848	2.64	9				
			4x6 list: $22; 800′				
24″	2332	3.20	11	48″	1232	1.70	6
36″	1584	2.18	8				
			4x8 list: $22; 900′				
24″	3110	4.14	14	48″	1643	2.15	8
36″	2112	2.82	10				
			6x6 list: $22; 900′				
24″	3498	4.65	16	48″	1848	2.47	9
36″	2376	3.17	11				

6x8 list: $22; 1,000′

24″	4664	6.04	22	48″	2464	3.20	12
36″	3168	4.11	15				

On the lists of joists already given 800′ is the quantity taken all through, while on this basement list the allowances run from 400′ to 1,000′. Hoisting is not required in the basement, and it is easier to handle lumber with a solid floor to walk on. A 2x4 takes far more time than a 6x8 in proportion to its size, for each joist or sleeper, large or small, has to be leveled.

The floor of No. 7 is laid on 6x8, 48″ centers, and 2 men handled from 1,500 to 1,600′ instead of 1,000 as in the table, but there were nearly 600 sq, while the table might be used for 20.

Some sizes not given may be found by taking multiples of those listed. Thus 8x8 would be twice as much as 4x8, although there is some little difference on account of the number of feet per day.

WAREHOUSE, STORE, AND MILL CONSTRUCTION: Posts and girders are not included in the following lists: allow them at $23 for lumber and $8 for labor, which add to joists. Joist lumber, $22; labor, $6.40 or 1,000 per day. It is worth while to remember that the cost of a floor at 6′ centers is not exactly twice that of one at 3′, for the extra joists come in both, and the wider the space the higher the proportion. Joists only are given; allow stirrups, anchors, cast-iron caps and shoes as may be required. For 6x12 and smaller sizes allow 1 double stirrup for each joist between girders, and single when 1 end rests on wall. Put stirrups ⅜x3 at $1, when dbl or to hang joist on both sides of girder; single, 60c. Only a few nails are required. The following stirrup table is made out for smaller sizes; for 8x14 and 16, allow about 10c per sq extra.

COMMON STIRRUPS

Centers	Per sq	Center	Per sq
2′	2.41	5	1.05
3	1.65	6	.91
4	1.28	8	.73

Centers	Am't for 22 sq in bm	Price per sq	Diff in lumber of $1	Centers	Am't for 22 sq in bm	Price per sq	Diff in lumber of $1
			6x12 list				
2	6996	9.05	32c	5	3036	3.94	14c
3	4752	6.15	22c	6	2640	3.43	12c
4	3696	4.80	17c	8	2112	2.75	10c
			6x14 list				
2	8162	10.56	37c	5	3542	4.59	16c
3	5544	7.18	25c	6	3080	4.00	14c
4	4312	5.61	20c	8	2464	3.20	12c
			6x16 and 8x12 list				
2	9328	12.06	43c	5	4048	5.25	19c
3	6336	8.20	29c	6	3520	4.56	16c
4	4928	6.38	23c	8	2816	3.66	13c

8x14 list

2	10893	14.08	50c	5	4554	5.90	22c
3	7392	9.56	34c	6	4107	5.32	19c
4	5750	7.45	26c	8	3286	4.26	15c

8x16 list

2	12438	16.08	57c	5	5398	6.99	25c
3	8448	10.93	39c	6	4694	6.08	21c
4	6571	8.50	30c	8	3755	4.87	17c

Labor is allowed as usual—40c per hour. As 1,000′ per day is taken 1c an hour more or less for 2 men means 20c a day. On the 8x16 list, for example, at 2′ centers this equals $2.49, or about 11c per sq; at 8′, 75c, or about 3½c. But if such exact figures are necessary it is better to refer to Part 2.

COVERING:—The cost of the various kinds of covering for joists, above and below, is now to be considered, and also cents per sq for diff of $1 in price of lumber.

Grade	Description	Price per 1000	Cost per sq	Cts
1	W. P. Sheeting	$23	$3.35	12
2	W. P. Sheeting	20	3.00	12
1	W. P. Shiplap	26	3.93	12
2	W. P. Shiplap	24	3.69	12
1	Y. P. Shiplap	22	3.45	12
2	Y. P. Shiplap	20	3.21	12
	Y. P. 3x6, 8, 10	20	8.50	36
	2x6, 8, 10	20	5.70	24
1	W. P. 4″ flooring	50	8.40	13
2	W. P. 4″ flooring	40	7.11	13
3	W. P. 4″ flooring	30	5.81	13
4	W. P. 4″ flooring	26	5.29	13
1	Y. P. 4″ flooring	27	5.42	13
2	Y. P. 4″ flooring	26	5.29	13
3	Y. P. 4″ flooring	23	4.90	13
V. G.	Y. P. 4″ flooring	35	6.45	13
1	Y. P. 2x6″ flooring	25	7.25	24
1	Y. P. ⅞x6″ flooring	25	4.37	12
1	W. P. 1⅛x4″	50	10.00	16
1	W. P. Fencing	28	4.73	12
2	W. P. Fencing	25	4.37	12
1	Maple 2¼″ flooring	40	8.45	14
	Maple sq edged 4″	32	6.00	12
1	Oak, common 2¼″	57	10.84	14
1	Oak, quarter-sawed	77	13.70	14

Building paper, tar felt, etc	.50
Plaster with wood lath	3.85
Plaster with metal lath	5.00
Metal ceiling, wood furring and painting	12.80
¾ beaded Y. P. ceiling, painting, but no furring	8.00
Anchors	.60
Best gravel roof	4.50

No. 1 W. P. sheeting, bridging, anchors, and No. 1 yp 4″ flooring with joists at 12″ centers, but none allowed, $9.50. At 16″ centers, as there is less nailing, deduct 20c.

All floor'g in foregoing table is ⅞″ thick unless otherwise stated.

OUTSIDE WALLS, GABLES & PARTITIONS:—A space 22x100 has been taken as a basis of calculation. Allowance of studs:

At 24″ centers 1 to 20″	At 16″ centers 1 to 12″
20″ centers 1 to 16″	12″ centers 1 to 10″
18″ centers 1 to 14″	

If work is properly done this is not too much material; on some buildings with angles and projections it might not be enough; on others again it would be too much. Bare studs are given. A day's labor for 2 men is taken at 640′ bm, which at 40c an hour is $10 per 1000. For difficult gables add from 25 to 50% to regular price. For each dollar above or below $20 in price of lumber, add or deduct the cents in the last col per sq. Thus 2x8 at 20″ with lumber at $22 would be $3.88. For bridging, if used, allow as follows:

2x4 level, 20c per sq or 2c per lf 2x4 angle, 25c per sq or 3c per lf
2x6 level, 28c per sq or 3c per lf 2x6 angle, 36c per sq or 4c per lf

2x4 list; Price, $20

Center	Quantity	Cost per sq	Cts	Center	Quantity	Cost per sq	Cts
12	1961	$2.75	9	20	1300	1.82	6
16	1667	2.33	8	24	1080	1.52	5
18	1395	1.96	7				

For 2x6 add 50% to 2x4 list; for 2x8 dbl the 2x4 list. Of course the same ribbon strip serves in all cases, and the last 2 figures are therefore a trifle high.

COVERING OF STUDS:—Nails are included. If sheeting, shiplap or flooring is put on at an angle from sill to wall-plate instead of level, add 50c, 60c and 70c per sq. A day's work is put at 1000′ of sheeting and shiplap. For figures on other material, metal lath, flooring, shingles, etc, see Part 2.

Grade	Description	Price per 1000	Cost per sq	Cents
1	W. P. sheeting	$23	$3.45	12
2	W. P. sheeting	20	3.10	12
1	W. P. shiplap	26	3.95	12
2	W. P. shiplap	24	3.71	12
1	Y. P. shiplap	22	3.47	12
2	Y. P. shiplap	20	3.23	12
1	W. P. fencing flooring, 6″	28	4.31	12
2	W. P. fencing flooring, 6″	25	3.95	12
1	Y. P. fencing flooring, 6″	20	3.35	12
1	W. P. siding, 6″	33	5.46	12
1	W. P. siding, 4″	33	6.00	13
1	Shingles 900	4	5.75	90

For drop siding allow 40c per sq more than shiplap of equal grade.
For ¾ ceiling, $6.
Tar paper, etc, 50c.
Plaster on wood lath, both sides of partition, 30c per yd, $6.68.

Plaster 1 side, or ceiling, on wood lath, $3.34.
For each cent of difference per yd in price of plaster add 11c to sq.
Back plaster on wood lath, and strips, $3.25.
Paint, 2 coats, $1.78; 3 coats, $2.22.

PITCHED ROOFS:—We now come to trouble, and plenty of it. This is the region of "turrets, towers and minarets." It is all well enough to draw them and write about them, but the question that confronts the estimator is not how well or how ill do they look, but how much do they cost. The old saying runs: "In buying a horse and choosing a wife, shut your eyes and trust to Providence." Among complicated roofs also that is the only safe rule to follow.

Let us take a plain roof for a standard and leave the complicated ones for discussion further on. A roof 22x100′ has been taken as a basis for the following figures. A day's work is 500′ bm. The figures are for rafters only. If ties and braces are used add 60c per sq. The allowance at 12″ centers is 1 to each 10 in; 16, 1 to 12; 20, 1 to 16; 24, 1 to 20. A liberal allowance is made for lumber. A roof does not require as much as a partition although the figures used are the same for equal centers.

2x4 list; $20 lumber

Centers	Quantity	Cost per sq	Cts	Centers	Quantity	Cost per sq	Cts
12	1760	$2.65	8	16	1467	$2.22	7
20	1100	1.67	5	24	880	1.34	4

For 2x6 add 50% to the price of 2x4; for 2x8 dble the price of 2x4.

I recently made out some bills of material for small passenger-stations with the usual hips and valleys. At the same rate for labor and material No. 1 was $3.70; 2, $4; 3, $4.56; while the plain list on same size and distance—2x6, 16″ centers—is $3.72. Another at 2x4, 16″, was $2.63; the plain list is $2.48. This is an illustration of the difference between a plain roof and one with hips and valleys, although by no means complicated. One of the worst roofs I have ever seen—No. 11—ran to $6 for 2x6, 16″ centers.

As to the "gingerbread" kind, there is only 1 way to estimate them—apart from the rule already given—and that is to take off each piece of lumber in a building where no 2 pieces are the same length and make a liberal allowance for waste, labor, and mistakes.

The foregoing list can be used as a basis and a guess made at the rest for an approximate test. If on a brick building add 65c a sq for a single wall-plate.

COVERING OF AVERAGE ROOFS PER SQ.

Sheeting $23	$ 3.88	Unfading-green	$10.50
Shiplap $26	4.25	Slatington, Pa.	9.00
Fencing flooring $28	4.75	Purple slate	11.00
Shingles $3.50	4.87	Red slate	16.00
Shingles dipped in stain	7.00	Interlocking tile	19.50
Brownville, Me., slate	14.50	Shingle tile	16.00
Monson, Me. slate	14.50	I. C., old style tin	10.00
Peach-Bottom, Pa. slate	12.50	I X Tin, O. S	12.00

Black-Bangor, Pa. slate. . .	11.00	Best gravel.	4.50
Sea-green slate.	9.50		

But on small work the price of slate may be increased 10 to 20%. (Slate and tile include paper; tile includes 1x2 strips.)

FURRING PER SQUARE

Centers	Size	Place	Price	Centers	Size	Place	Price
16″	1x2	Walls	$1.80	12	1x2	Walls	$2.30
16	1x2	Ceilings	.75	12	1x2	Ceilings	.95
13	1x2	Interlocking tile	1.00	16	2x2	Ceilings	1.20
12	2x2	Ceilings	1.50	16	2x2	Walls	2.70
12	2x2	Walls	3.30				

PLATFORMS:—Warehouses of all kinds and depots usually have platforms about 4′-6″ above grade. For plank footings, 12″x12″ uprights and girders, braces, nails and bolts, allow $9 per sq. For 3x12 joists, 12″ centers, $9 per sq; for 3″ plank on top and 2″ to enclose front, $9.50 per sq. With lumber at $20 make the complete figure 29c per sq ft, the extra allowance being for bridging, inclines, stairs, etc. These figures are from actual quantities for about 24,000 sq ft. But sufficiently strong platforms of lighter construction can be built for 19c—say 3x10 joists 24″ centers, and 2″ top: and for cedar pile heads, 6′ centers, 8x10 sills 8′ c. to c., 3x10 joists 16″ c., 3x10 covering with lumber at $19, a western engineer gives me his cost at 26c.

On ground with 6x8 sleepers 4′ centers, 3″ covering, 13c; 2″ covering, 10c. For other sizes, spacing of joists and covering, see under "Basement Sleepers and Covering." Platforms may require more labor than basement floors, owing to frost, grade, etc, and extra allowance must be made if required. The foregoing figures cover average work.

A plain roof covered with gravel may be put over platforms for 14c per sq ft. Long, plain umbrella-sheds with iron posts, wood framework, gravel roof, gutters, sewers, but no paving, 48c per sq ft.

WOOD FENCES:—In most cities they are limited to 8′ high, for in the old days "spite fences" sometimes soared higher than the shingles.

With 8″ cedar posts, 10′ long, about 10c per lf, 4 rails in hight, close-sheeted, without paint or gates they are worth 45 to 50c per lf. Mineral paint at 5c to 6c per sq yd per coat is close enough. With 1 coat of paint 55 to 60c. Large dbl wagon gates for such fences run from $30 to $40 hung. The cost of boring post holes for lower fences is the same. For a 4′ fence, unpainted, 25 to 30c per lf. It is well to remember that paint sometimes goes on 1 side, sometimes on both.

PICKET FENCES:—There are so many different kinds that we must be content with the fair average of 30c per lf, unpainted, for a reasonable number of ft; a short fence might cost twice as much.

TIN & GALVANIZED IRON

Cornices of average design, 1¼c per in of width, and dentils, brackets, etc, extra. Gutters, 15 to 35c; downspouts, 20 to 30c; 7″ flashing, 8c; 14″, 16c; 14″ valleys, 12c; 20″, 15c.

Tin roofing, I X, $12 per sq; skylights, 60c per sq ft; large skylights like those on No. 7, of many styles, 50c per sq ft.

PLASTER

Allow for metal lath and 3-coat white finish 50c; for wood lath and same finish 35c; sand finish is worth from 3 to 5c more than white coat.

MILLWORK

After the walls are up, the roof on and the building plastered, we come to millwork. Only a general idea can be given here of this; and for an approximate figure it is better to give openings complete than millwork alone. Labor, paint, hardware, glass, stone sill and lintel, are therefore included.

DOORS:—Outside glass door, 3x7x1¾ for brick, $25; for frame, $19. Inside door, 2-8x7x1¾, $13. Add $6 if a transom is used in any of these doors. The price for an outside door may be run up to $100, and beyond. A white pine door at $8 with hardware at $3 is allowed. An ordinary sliding door painted, $35; hardwood, $50 to $100.

WINDOWS:—There is no deduction made for brick or plaster, as these are attended to in the mason's part. Sash are 1¾ thick with D. S. glass; 3 coats of paint; stone sills; a fair quality of hardware.

For an opening about 3x7-6, brick, $16.50; frame, $12.50; opening, 2-6x6-6, brick, $14.50; frame, $10.50. No allowance is made for blinds See Part 2.

BASE:—For yp, 16c per lf with grounds and paint; for hardwood, 22c.

WAINSCOTING:—Paneled and painted yp with grounds, 35c per sq ft; ¾ matched and beaded, 12c; pan and hard oil finished oak with grounds, 50c; m and b, 17c.

For yp ceiling partitions without framework, allow 16c per sq ft painted on both sides. For a large space this price is too high; but for bath-room partitions standing clear of the floor with angles and troublesome corners, it is too low.

STORE FRONTS:—On ordinary fronts filled with plate glass, with dbl doors and transoms, sash below window for cellar, counter-shelf, paint, hardware and labor complete, $1 per sq ft. No iron or steel included. From this price we might easily go to $5.

CASES:—An approximate figure may sometimes be of value: For a case divided into holes 18″ square allow 16c per sq ft at 12″ deep; and 27c at 24″ deep. With holes 3 ft sq, 11c for 12″, and 16c for 24″. A back of ¾ ceiling is allowed in both cases: if left off, deduct 5c per sq ft. Lumber is put at $25; labor, $35. Less than this may often be sufficient, but 25% more might be wasted on labor. Face measure, not shelf measure, is taken. Thus, a case to fill the end of a room 10′x20′, or 200 sq ft, would cost, at 18″ holes 12″ deep, $32. Add profit or percentage required.

CORNICE ON FRAME BUILDINGS:—A plain cornice without brackets, painted and finished, runs to 40c per lf. Brackets cost from 15c to $2.

Cornice boards, ridges and plain lumber may at this writing be put in, if of white pine, at $80 per 1,000 in place.

PAINT

For 2-coat work allow 15c; 3-coat, 20c; for pine, plain oil finish,

25c; rubbed down, 35c; hardwood, 35c; rubbed down, 50c. Sometimes $1 is not enough for hardwood.

PERCENTAGES

I have taken 22 frame buildings of all sizes and styles, and from actual bids put in or work done, have made out the following average percentages. I meant to take more as a basis, but found that the result would have been practically the same with 44 as with 22. Some of the buildings were let when prices were high, and some when they were low, so that a fair average is obtained. Of course, a little judgment is required to get good results from the tables for an approximate estimate,—on an Omaha church, for example, the brickwork is 23 and the millwork 16; on certain flats with hardwood finish, the figures are reversed. Coal-sheds, fences, sidewalks, furnaces, mantels, and such extras are not included. The averages in the brick buildings have been taken from a list of 36. They range in price from $5,000 to $50,000. All kinds are listed—private residences, stores, flats, warehouses, schools, hospitals, railway stations and stables. Heating is not included.

It is not always easy for architects, engineers and others who have to figure carpenter work to get at the labor. The lumber and plain millwork are often estimated fairly well, and then anywhere from 25 to 60% of the total taken for labor. The following lists of different classes of buildings will give a better idea of what the figures should be.

Class of Work	Frame buildings	Brick buildings
Excavation, brick and cut stone.	15.8	41.0
Plaster.	8.3	5.6
Lumber.	19.3	11.0
Millwork and Glass	20.6	12.0
Carpenter Labor.	17.9	9.0
Hardware.	3.5	2.5
Tin and Galvanized Iron	2.3	3.0
Plumbing and Gas-fitting.	6.8	4.3
Paint.	5.5	3.4
Iron and Steel.		5.6
Roofing.		2.6
	100.0	100.0

It will be observed that some of the items under "brick" are lower than the same items under "frame." Of course the high percentage of mason work necessarily reduces the other figures, but part of the difference is due to the fact that warehouses are listed, and the inside finish is thus reduced. The other lists will give a better percentage, but it is well to take a general average of all kinds of buildings, and let the architect or contractor make an allowance for any departure from a normal type.

The tables may be used to estimate the cost of enclosing a building. By leaving out part of the millwork, paint, labor, hardware, etc, a

fair idea may be obtained; and a certain item being known the value of the complete building may be found. Hardware at $350 means a $10,000 frame house.

In the brick list there are 17 buildings, or about half, with iron and steel—for columns, beams, etc. The percentage varies more in this item than in any other: 2, 7, 12, 3, 6.5, 5, 9, 7, 7, 4, 2.5, 1.5, 8, 4, 2, 7, 8. Brick and stone run steadily from 38 to 50 with most buildings about 44; but one house is only 25, as the inside finish, plumbing, etc is of a superior quality. The millwork on the same building is 25. Carpenter labor, paint, hardware, plumbing, plaster, and tin do not vary much, and when they do take a bound the reason is generally clear, so that in making an approximate estimate variations from what may be taken as a standard can easily be noted.

There is even less variation on frame than on brick buildings. Lumber, millwork and brick keep remarkably steady in the same class.

When selecting the frame buildings I ran across one that could not be listed as there was no foundation or inside finish except that the walls and ceilings were sheeted and a floor laid. It may be taken as a type of shed construction in the frontier style of architecture. It is 30′ 6″ by 150′, 2 stories high, with 2x6 studs and rafters covered respectively with drop siding, sheeting and shingles. The percentages are: Lumber, 56; millwork, 10.5; iron and hardware, 4.5; carpenter labor, 21; tin, 3.5; paint, 4.5.

Another building not listed owing to partial fireproofing is No. 3. The 2 fronts are built of a hard Wyo. pink stone. The stone is backed with brick, and the rear walls are of brick. Joists 3x14 rest on 2 lines of iron cols and steel I beams. The walls and ceilings are lined with fire-proofing, and the partitions are built of hollow tile. Half the finish is oak, and the other half yp. Without marble, elevators, heating, plumbing, electric work and architect's percentage the cost was $125,000. The bids were read in the presence of the contractors so that the cost is well enough known, as indeed that of most buildings is among the elect. The building was publicly sold in 1902, and the newspapers gave the price but not the percentages. We got the contract, and here are the figures:

Excavation and brick....	28.15	Plaster.................	3.36
Stone.................	18.34	Tin and copper.........	1.65
Steel and Iron..........	14.56	Gas-fitting.............	.60
Lumber................	4.22	Gravel roof.............	.20
Carpenter labor........	4.55	Hardware..............	1.52
Millwork and glass......	11.63	Painting...............	2.20
Fire-proofing...........	9.02		
			100.00

The following list is taken from 5 good brick houses.. No. 4 has gas but not plumbing:

RESIDENCES

Cost	Excavation, Br'k & Stone	Plaster	Millwork and Glass	Lumber	Carpenter Labor	Paint	Hardware	Tin and Slate	Plumbing and Gas	Ornam'l Iron	Steel and Iron	Gravel Roof
$38,000	51.8	8.3	13.0	7.1	8.3	3	3	5.5	....	..	....	....
18,600	36.5	6	21.8	13	10	4.7	3	5	....	..	....	....
19,500	35.2	5.2	19.1	12	11.3	9.2	3.5	4.5	....	..	....	....
8,200	25	5	25	14	10	6	2.5	2.5	5	..	....	....
24,400	34.4	5.4	19.5	12.7	10	5	3.5	5.5	1	3	....	....
Average	36.58	5.98	19.68	11.76	9.92	5.58	3.1	4.6	....	..	....	...

WAREHOUSES

Cost	Excavation, Br'k & Stone	Plaster	Millwork and Glass	Lumber	Carpenter Labor	Paint	Hardware	Tin and Slate	Plumbing and Gas	Ornam'l Iron	Steel and Iron	Gravel Roof
$34,000	53.3	....	4.1	21.9	9.2	1	2	.3	....	..	7.2	1
14,000	50	....	5	21.1	10	2.5	2	3	....	..	2	4.4
17,000	44.9	....	12.5	17.5	10	2.3	2.8	1.2	....	..	6.8	2
26,000	51.5	....	6.5	17	9	2.5	2.5	2	1.5	..	6.5	1
12,000	50	....	8	14.5	8.5	3	2.5	2.5	3	..	7	1
Average	50	....	7.2	18.4	9.3	2.3	2.4	1.8	....	..	5.9	1.9
$15,000 without masonry		....	19.5	22.4	19	2.4	3.7	3.6	10.4	..	19	....

STORES & FLATS

Cost	Excavation, Br'k & Stone	Plaster	Millwork and Glass	Lumber	Carpenter Labor	Paint	Hardware	Tin and Slate	Plumbing and Gas	Ornam'l Iron	Steel and Iron	Gravel Roof
36,000	36.9	6	15	13.8	10.2	3.5	2.8	5.8	....	..	4	2
34,000	40.1	6.5	18.8	12.2	9.7	5.9	2.2	2.3	....	..	1.3	1
44,500	32.2	6.6	20	14.1	12	6	3	5.1	....	..	....	1
29,000	36	8	20	7.5	9	3.5	3	5.5	4.5	..	3	....
11,000	25	6	20	12.5	9	4	2	3	4.5	..	12	2
12,500	38	7	12	10	9	6.5	2.5	4	4	..	7	....
12,000	40	5	13	10	10	3	2	8	4	..	5	....
$verage	35.4	6.4	17	11.4	9.8	4.6	2.5	4.8	4.2	..	5.4	1.5

SCHOOLS

Cost	Excavation, Br'k & Stone	Plaster	Millwork and Glass	Lumber	Carpenter Labor	Paint	Hardware	Tin and Slate	Plumbing and Gas	Ornam'l Iron	Steel and Iron	Gravel Roof
Cost ran	46	6	12	10.5	9	4.5	2.5	4.5	5	..	....	Slate
from	48	6	9	10	9.5	3.5	2.5	3	3.5	..	....	5
15,000 to	41	7	11	15	13	5	3	2	3	..	....	....
45,000;	45	6	11	10.5	10	4	2	4.5	4	..	....	....
most	49	6.5	11.6	11.6	9.7	4.6	2	5	...	..	....	....
from	45	6	10	11	10	3	3	3	4	..	....	5
22,000 to	45	6	10	11	10	3	3	3	4	..	....	5
45,000	42	6	12	12	11	5	3	2	7	..	....	....
8 and 16	49	5	9.5	11	8	3	2	5	2.5	..	2 ..	3
rooms	50.4	5.8	12	10.3	9.6	4.3	2.2	5.4	...	..	....	....
	54.6	4.8	9.2	12.4	11	3.8	2.1	2.1	...	..	....	....
Average	46.8	5.9	10.7	11.4	10.1	4	2.5	3.6	4.1	..	....	....

REMARKS:—In No. 3 of the "Warehouse" list a large plate-glass front raises the millwork and reduces the masonry; in No. 2 the gravel roof has a high percentage, but the building is low, and the cost of a roof 1 story from the ground is, for our purpose, the same as for 10. In one building the percentage is given without masonry.

Under "Stores and Flats" it will be observed that the average line foots up 103 instead of 100. This is owing to dividing steel and iron, gravel roof, and plumbing by the number of buildings instead of by 7. It is interesting to notice how closely the percentages run. A reasonable profit being allowed, one might almost be safe in estimating the hardware in a building and signing a contract based upon the proportions in a table. Judging from bids I have heard of and read, there be those who do not build upon so sure a foundation.

MANUFACTURING BUILDINGS

We live in an age of machinery; and the house that held the old anvil under that spreading chestnut tree is far too small for our requirements. A class of buildings has arisen that belong, like the skyscraper, to the American style of architecture. Like the skyscraper also they belong rather to the engineer than to the architect. The latter is merely called to hang a curtain over the framework to keep the cold and rain out—and the curtain in some of them is of expanded metal and concrete only 2″ thick. In 1901–2 I had the pleasure of making the estimates for 3 of the latest and best specimens,—Nos. 7, 8, and 14.

These buildings are now to be found all over the country for electric-light works, locomotive-shops, machine-shops, foundries, steel works and rolling-mills, tin-plate works, boiler-shops, bridge-building and ship-building establishments, pipe-foundries, and manufacturing plants of all kinds which are equipped with electric traveling-cranes that lift anything from 120 lbs. to 120 tons.

When in the fall of 1902 No. 7 was glittering with paint and the voice of the captains was shouting from afar, "Schuler," sent by the German government to see what his American cousins were doing, stood as he entered the door and said enthusiastically, "It ees the finest I have seen!" "Well," I said to him, "what of Krupp?" "Ah, he is the big one; 35,000 men working there."

The following percentages are from the under side of the water-table. Floors are included. It is seldom that two foundations are alike, and the only safe criterion is from the floor line up. Skylights cover from $\frac{1}{3}$ to $\frac{1}{2}$ of the roof surface. No. 8 is 150x500; No. 7, 150x400; No. 14, 150x310. Machine foundations, tracks, heating and lighting are not included. Extra cross walls account for the high rate of the brickwork in No. 8, and cheap lumber and less of it in proportion, on account of leaving out gallery, etc, makes the difference in that item.

	No. 8	No. 7	No. 14
Brick	16.4	10.2	13.3
Cut stone	1.2	1.1	1.5
Lumber	6.2	10.0	6.4
Millwork and glass	5.5	6.0	6.0

	No. 8	No. 7	No. 14
Carpenter labor	4.1	5.3	4.0
Gravel roof	1.7	1.4	1.7
Skylights and glass	8.0	9.5	10.6
Tin, copper, galv. iron	1.1	1.1	1.5
Steel lintels for doors and windows, and hardware	5.2	5.0	7.0
Painting	2.4	2.3	1.9
Steam-, water- and power-piping	3.2	3.1	2.0
Structural steel	45.0	45.0	44.1
	100.0	100.0	100.0

Cold-water painting is not included: see Chap 15.

RELATIVE COST OF BRICK AND GLASS

In general glass costs twice as much as brick. In the preliminary study of a building it is often desirable to know how the total cost is affected by putting in or leaving out windows or doors.

In large manufacturing buildings with unplastered walls, where double and triple windows or wide doors take up from $\frac{1}{4}$ to $\frac{1}{2}$ the space, common brick is to glass as 6 to 15 in 13″ walls; and as 1 to 2 in 17″. In the one case we have only the brick to consider; in the other, frames, sash, glass, labor, paint, hardware, stone sills, and steel lintels.

For the average single window with sills and lintels in a 13″ wall, 11 to 25; in 17″, 3 to 5.

In ordinary buildings with openings about 3x7, glass costs twice as much, and not only so, but the mason often forgets to deduct the brick and both prices go in. Here, in addition to the other items, we have jamb linings and inside finish. Allow 11 to 28 in 13″, and 1 to 2 in 17″.

Sash are estimated $1\frac{3}{4}$, glass, D. S., paint 20c which allows 3 coats, brick at $10 wall measure, steel lintels in place, $85 a ton, which is enough in ordinary times.

In frame buildings there is practically no deduction made for studs, sheeting, and siding, so that glass is an extra.

PART 2
DETAILED ESTIMATING
CHAPTER I
EXCAVATION

Excavation is measured by amount of material displaced.

The approx allowance was from 15c to $1 per cy with an average of 25c. It is not easy to add more without knowing the local surroundings. Actual figures on a few buildings may be given, however, to illustrate the different conditions.

On Bennett's store, erected in 1901 in the center of Omaha, with good, hard soil, the cost of excavating 4,000 cy was 25c,—the haul was about ½ mile.

On No. 2 bids were received for 15c, but there was no haul and wages were lower. This figure will often cover work done outside of the cities.

On No. 7 the average for many thousands of yds was 77c, but water was struck a little below the surface and the work was done in winter. The difference between winter and summer was shown near the same building when more than 1,500 cy were excavated for 45c. A contractor has to watch the thermometer—and he is sometimes justified when he refuses to stand by his summer estimate.

For filling and tamping several thousand yds of sand inside of No. 7 the labor alone was 27c.

On one Omaha building where the contractor struck water, the cost of excavation was $1.50. This is 10 times as much as on No. 2, and shows how impossible it is to give figures without examining the ground. There is danger below ground. On an Omaha hotel built more than 10 years ago the contractor had to pay a ruinous price for his excavation in wet ground.

For average rock, $1 per cy; on large work with steam drills, 75c. We have not the same soil here as in New York, where the foundations for whole streets of houses are blasted out of the solid. But in cities the work is sometimes more expensive on account of the cost of necessary precautions, etc. For 400 cy rock excav. above grade in Boston in 1903 the average of 11 bids was $3.60 per yd, the lowest $3, the highest $4.50.

In case an embankment or slope has to be made allow what a stair-builder would call 18 run to 12 rise, and the earth will stand. Sometimes 1 to 1 is enough.—See chapter on "Municipal Work" for description of excavating machine.

Sheet-piling is hard to estimate without seeing the ground. A fair allowance is 15c per cy.

CHAPTER II.
PILING

In the softest ground, with wages from 17c to 20c an hour, it costs 5c per lf to drive ordinary piles in the ordinary way. The highest figure, where the conditions are not so favorable, should not be more than 10c at the same rate of wages. Pointing and cutting off the top included. No. 7 and other buildings of the plant are set upon pile foundations, and 5c to 6c covered all work, except one lot which cost 8c., But these prices would not apply in all places, or in any place with few piles. Piles for

abutments cost about 20c for labor; for pile bridges, from 7 to 12c, depending upon interruptions from trains, etc. On an Omaha building, erected in 1903, the contract price for labor was $1 per pile. The piles averaged about 20′ long.

The building contractor usually has so little to do with pile foundations that the foregoing prices are sufficient to give a fair idea of what driving is worth. One of the blocks shown in No. 6 is piled, but comparatively few buildings are in Omaha or Lincoln. Nevertheless there are quite a number which have cracked and sunk so much that a few piles in the right place would have been of wonderful value,—or at least wider footings.

Oak piles with a 10″ head are worth from 16 to 21c per lf, according to length; white-cedar (which outlast oak if above ground) are about the same price.

CHAPTER III.
CONCRETE

LABOR:—On No. 2 the price by piece-work was 50c per cy. The work was really worth 75c. The rate of wages in the neighborhood was $1.50.

By taking 65% of the wages paid to 1 laborer for 10 hours, a safe figure for mixing average concrete may be found. A recent engineering table gives 90%, but that is too much unless some special reasons exist which make the work difficult.

On No. 7 the average cost of several thousand yards was 95c, but this was for concrete only. The average labor on forms was 28c per yd additional. Of course, small foundations cost more than large ones. Forms are necessary when ground is wet, when piers have a special shape, or rise above the level. The engineering table referred to above sets the cost of forms at 35c to 85c.

But while 95c was the average on the main buildings, on the machine foundations where special and complicated forms had to be made the cost of concrete mixing ran from $1.50 to more than $3, with an average for several hundred yards of $2.05. In addition to this the labor on forms per cy was $1.42. The quantities are small on such work, the angles are many, bolts are to set, and the work has to be carefully leveled and smoothed on top. The excavation for the same foundations ran to $1.

The unloading of sand and stone from cars to ground only for the work on No. 7 ran to 12c per cy of concrete in wall. This figure has to be added to mixing if material is not delivered with teams.

The average cost of lumber and nails for forms was 10c per cy of material in wall. Of course the same forms and lumber can be used several times. If instead of piers there is a continuous foundation the forms cost only about half as much for labor, and there is less lumber used. With piers, No. 7 required 7,000′ bm and 3 kegs of spikes to each 1,000 yds. For continuous basement walls allow studs, shores and planking full hight around about ¼ of building and change when work is dry. Put labor at $10 per 1000.

On another building with about 700 yds, the complete cost of unloading, making forms and finishing concrete was $2. A day's work for 2

men may be averaged at 3 to 4 cy. This does not mean 50 ft below the surface of the ground. The average foundation in Nebraska is seldom more than 10 to 15 ft below street level.

All of the heavy foundations for No. 8 were mixed with machines at a cost of 75c: forms about 50c extra. No. 7 was hand-mixed.

While writing this part a Chicago contractor, who allows $1 to $1.35 per cy, informed me that on a certain contract for 4,000 yds in Louisiana in 1901, 30 men with a concrete-mixer put in 105 cy per day. The difference is not so great as one might expect, but with a machine there is a better assurance of good mixing if work is done by contract; and even the best cement is wasted unless the mixing is well done. This was in New Orleans where the negroes do not work so hard or effectively as whites do elsewhere. On another large contract in Chicago 20 men with a mixer put in 100 yds a day. In both cases the engine man is included. One maker's machine costs about $800 without engine; others are in the market complete with 3 h.p. gas engine, for $450; for horse, $150.

Different sizes of another, and a popular, machine run in price from $300 with nothing but the skids and pulley, to $1600 mounted on a truck with steam-engine and boiler. The reports from more than a score of users give results ranging from 60 to 350 cy in a day according to the size of the machine. The cost is set down by some as half that of hand labor. An allowance of from 5 to 8 yds per day, per man, is given.

A correspondent in the "Engineering News" of Jan 28, '04 describes his experience in mixing 20,000 yds in the north of England. Part was mixed with machine, part with hand labor. With the machine 13 men averaged 60 cy per day: with hand labor, 11 men, 30.

On railway shops with walls and roof of concrete, erected in New Jersey in 1901, a mixer was found to be economical when the concrete was 18″ thick. Below that hand mixing was cheaper. The concrete was mixed with the machine and put in place for 50c per cy.

On the government breakwater at Buffalo the labor on concrete was $2.41 per cy. On the New York storage reservoir, .574 days for 1 man was time required per cy for work from 27 to 10 ft below the surface; and .485 days from 10 to 6 ft below. In both cases the concrete was wheeled into place. A St. Louis engineer mixes concrete for street paving at 30 to 40c with a machine, and common labor at $1.75, teams $4, engine at $5 for a 10-hour day. But street work is easier reached than a deep foundation, and the surface is larger.

Only actual measurement is allowed in this book—corners are not doubled, openings, etc, not included.

PRICE:—Crushed stone costs from 5 to 6c per 100 lbs FOB Omaha and Lincoln. A fair price is 5½c. In a yd of concrete we have therefore, for stone, $1.27; sand, 35c; Am. Portland cement, $2.50; hauling sand and stone from cars, say, 3600 lbs, 75c; mixing, $1; water, 15c, a total of $6.02. The Omaha rate for water is 15c per cy, but the meter rate is less than half. On a large warehouse recently erected near Omaha, the contractor put in the concrete for a trifle less than $6, and this included his profit, but the cars ran to the ground, so that

there was no hauling, which may cost 30c or $1, according to distance,—and wages and material were lower than now.

If natural cement is used, a deduction of $1.40 a yd may be made; if imported Portland at $3.50, the price must be raised to suit. If there is no hauling to be done, deduct that item. Sand at river is 15c; on cars Omaha, 55 to 60c; at building, 70c to $1.

MATERIAL:—The Engineering Dep't of the B. & M. R. R. allows for average concrete as follows: 2,300 lbs of crushed stone; ½cy of sand; 1 bbl of cement; $1 to mix.

From 2,300 to 2,350 lbs of stone is a fair allowance. From a number of cars weighed by the U. P. R. R. for the viaducts at 16th and 24th Sts, Omaha, it was found that 2,260 lbs were sufficient for a yd of concrete; but on small work on the line where there is more chance of waste, 2,500 are allowed and the excess used for filling. For the foundations of No. 7, 2,300 were allowed and 2,200 used, along with 6-10 of a yd of sand.

Stone and sand would be bought by the cy if contractors had their way; but the dealers prefer to sell by weight on account of freight charges. If sand comes wet it does not take so much to make a ton as when dry; and granite weighs more than lava although a cy of the one does not fill any more space than a cy of the other. Of course concrete can be made more expensive by increasing the quantity of cement. Two barrels are given to the cy in a rule before me; 1⅛ to 1¼ is a quantity often used. On No. 7, 1 1-10 of Am. Portland was the unit. But there is a certain point beyond which more cement means waste, and it is the province of the architect or engineer to discover it and stop. The contractor is apt to make the discovery ahead of either.

But as the business of an estimator or contractor is largely to follow the specifications and ask no questions, it is well to give a rule for quantities based upon different proportions. Take 4 for illustration: Cement, 1; sand, 2; and stone, 4 or 5 is considered the best, but an excellent concrete can be made with more stone.

No. 1—1, 2, 6; No. 2—1, 2, 4; 3—1, 2, 2; 4—1, 4, 10. (The large mill of an eastern cement factory is built to the roof on this last proportion though it seems rather weak.)

Let us consider No. 1: There are 27 cf in a cy. On a 1, 2, 6 basis this means 3 cf of cement, 6 of sand, and 18 of *solid* stone. But it has been found by experience and experiment that about ½ more material is needed to fill the spaces between the crushed stone, and again 35-100 of material to fill the voids between the grains of sand, so that using .4 for sand voids gives a large enough extra cement allowance. Stone then being 18 gives 9 cf of space, and sand being 6, gives 2.4 cf of space, or altogether 11.4 cf we are short owing to the voids. Adding 1, 2, 6 we have 9 parts; dividing the 11.4 cf by 9 we have 1.267 cf for a unit. To keep the materials in the same proportion add 1.267 to 3, making 4.267 cf of cement; 2.534 to 6, making 8.534 of sand; and 7.6, or 6 times 1.267, to 18, making 25.6 cf of crushed stone, a total of 38.4 cf.

Trautwine gives us the exact proportion between uniform crushed stone and voids as .53 stone and .47 space, but the half is exact enough for practical purposes: sand runs about .65 solid to .35 void,—U. S. experiments .349. "It is advisable that the voids be filled or more than filled,"—and this puts a stop to using too much stone, but leaves room for sand. For 1 cy in place the foregoing figures allow 1.43 of loose material; at the Mississippi jetties where blocks of 25 to 72 tons were used, the allowance was 1.66, as the concrete below water stood only 60% of the loose material. There the proportions were: Portland cement, 0.16; sand, 0.45; clean gravel, 0.24; broken stone, 0.81, a total of 1.66. Concrete at 1, 2, 6 stands: .16, .32, and .95, a total of 1.43.

So much for 1, 2, 6; let us now try 1, 2, 4. There are 7 parts in this proportion, and 27 divided by 7 gives 3.857. This makes 3.857, 7.714, 15.428. Taking the half of stone and 4-10 of sand for voids, we are short 10.8 cf. The 7th part is 1.543. This added in the proportion of 1, 2, 4, gives 5.4 cement, 10.8 sand, 21.6 crushed stone, a total of 37.8 cf. Here sand is half of stone, and the voids will not only be filled but the stone will not touch; and this is consequently a better concrete than 1, 2, 6.

But take 1, 2, 2: Worked out in the same way this is 7.34 cement and 14.69 for both sand and stone, a total of 36.72. There is less waste through voids in this proportion, and consequently the total is smaller. It is too rich, but is introduced to show that by this method the quantities regulate themselves. Theoretically sand should be half of stone, for with .47 void .5 insures enough material to keep stone from touching, but if the quantity of stone is fixed by the proportion chosen, enough sand and cement have to be added to make up the yard. It is often said that a cy of concrete requires a cy of crushed stone, a bbl of cement, and half a yd of sand, but that depends upon the proportion. Here we require nearly 2 bbls of cement and only a little more than half a yd of stone.

Having found the cf it is necessary to mult stone and sand by weight if tons are desired; and divide the cf of cement by 4.4 to get loose bbls, or 3.8 to get packed.

No 4 is 1, 4, 10: $27 \div 15 = 1.8 \times 1 = 1.8$; $\times 4$, 7.2; $\times 10$, 18. The voids$=11.88 \div 15 = .793$, which added in the proportion of 1, 4, 10 equals 2.59, 10.37, 25.93, a total of 38.89. So may any proportion be worked out.

In the Cathedral of St. John the Divine, the proportions are: 1 Portland cement, 2 sand, 3 quartz gravel; and 11,000 cy took 17,000 bbls. The rule comes close enough to actual figures to be satisfactory. The quantities are 6.225, 12.45, 18.675, a total of 37.35. At the cathedral a cy took 1.545 bbls of cement. At 3.8 cf of packed Portland cement to a bbl our rule gives 1.68; at 4 of Western Rosendale, 1.556. "A bbl of Rosendale is so packed at the factory that loose it will measure 1.25 to 1.40; Western Rosendale 1.1; Portland 1.2."

After I had worked out the foregoing method, I read the following one from the report of The American Railway, Engineering and Main-

tainence Of Way Association made in March, 1903. They give the stone voids at .47 and the sand voids at 32.3. On this basis "we have theoretically cement 1; sand 3.1; broken stone, 6.5. Adding 5% of cement and reducing to the basis of cement 1, we have cement 1; sand, 2.96; stone, 6.2, or nearly 1, 3, 6." Although they do not give the method of working out the proportion, which is not seen at first glance, we can get it by setting 100 of stone as the unit instead of 1 of cement: 100 of stone gives 47 of voids; 32.3% of 47 equals 15.181, and these figures stand in the proportion of 6.5, 3.1, 1. Their recommendation is to add 5% of cement, making 1.05. Turning this 1.05 into 1 for a unit of cement, sand is 2.96 and stone 6.2.

"Various writers place broken stone and gravel voids at from 41 to 50%. Experiments show that with ordinary sand, voids will vary from 31 to 38%."

In the example they gave 5% extra of cement is used, and they go from that to 10%. With the sand voids averaging .35 the method I worked out allowing .4 gives enough cement.

This committee also made some interesting experiments with blue limestone and found the following results:

	Weight per cf	% of voids
Crushed rock with dust screened out.	89.22	45.16
Stone passed thro' 2″ ring and retained in 1″.	86.74	47.70
Stone passed thro' 2 and retained in ½.	77.70	50.66
Pea size.	75.44	49.63

For western natural cement they set 1 bbl at 265 lbs, with 3 paper sacks as the equivalent, or 2 jute sacks with 133 lbs each; eastern cement runs to 300 lbs. "Portland cement shall not contain less than 376 lbs, and 4 sacks shall equal 1 bbl." A bbl of Portland weighs about 400 lbs gross, 380 net.

An approximate way of finding the barrels of cement for any proportion is to divide 11 by the sum of all the parts: No. 1 by 9; 2 by 7; 3 by 5; and 4 by 15, giving 1.23, 1.57, 2.2 and .74 barrels of cement—then multiply by the parts of sand and stone to get barrels, which multiply by 3.8 for cubic feet. No. 1, for example, would have 2.46 barrels of sand, and 7.38 of stone.

The following tables save the trouble of calculation. They are supplied by the

CONTRACTORS PLANT CO., BOSTON.

Concrete with 2½ inch Stone.						Concrete with Gravel ¾ inch and under.					
Proportions of Mixture			Req'd for 1 c yd			Proportions of Mixture			Req'd for 1 c yd		
Cement	Sand	Stone	Cement Bbls	Sand c yds.	Stone c yds.	Cement	Sand	Gravel	Cement Bbls	Sand c yds	Gravel c yds
1	1	2.0	2.72	0.41	0.83	1	1	2.5	2.10	0.32	0.80
1	1	2.5	2.41	0.37	0.92	1	1	3.0	1.89	0.29	0.86
1	1	3.0	2.16	0.33	0.98	1	1	3.5	1.71	0.26	0.91
....	....	....	....	....	....	1	1	4.0	1.55	0.24	0.94
1	1.5	2.5	2.16	0.49	0.82	1	1.5	3.0	1.71	0.39	0.78
1	1.5	3.0	1.96	0.45	0.89	1	1.5	3.5	1.57	0.36	0.83
1	1.5	3.5	1.79	0.41	0.96	1	1.5	4.0	1.46	0.33	0.88
1	1.5	4.0	1.64	0.38	1.00	1	1.5	4.5	1.34	0.31	0.91
....	....	....	....	....	....	1	1.5	5.0	1.24	0.28	0.94
1	2.0	3.0	1.78	0.54	0.81	1	2.0	3.5	1.44	0.44	0.77
1	2.0	3.5	1.66	0.50	0.88	1	2.0	4.0	1.34	0.41	0.81
1	2.0	4.0	1.53	0.47	0.93	1	2.0	4.5	1.26	0.38	0.86
1	2.0	4.5	1.43	0.43	0.98	1	2.0	5.0	1.17	0.36	0.89
....	....	....	....	....	....	1	2.0	6.0	1.03	0.31	0.94
1	2.5	3.5	1.51	0.58	0.81	1	2.5	4.0	1.24	0.47	0.75
1	2.5	4.0	1.42	0.54	0.87	1	2.5	4.5	1.16	0.44	0.80
1	2.5	4.5	1.33	0.51	0.91	1	2.5	5.0	1.10	0.42	0.83
1	2.5	5.0	1.26	0.48	0.96	1	2.5	5.5	1.03	0.39	0.86
1	2.5	5.5	1.18	0.44	0.99	1	2.5	6.0	0.98	0.37	0.89
....	....	....	....	....	....	1	2.5	7.0	0.88	0.33	0.93
1	3.0	4.0	1.32	0.60	0.80	1	3.0	5.0	1.03	0.47	0.78
1	3.0	4.5	1.24	0.57	0.85	1	3.0	5.5	0.97	0.44	0.81
1	3.0	5.0	1.17	0.54	0.89	1	3.0	6.0	0.92	0.42	0.84
1	3.0	5.5	1.11	0.51	0.93	1	3.0	6.5	0.88	0.40	0.87
1	3.0	6.0	1.06	0.48	0.97	1	3.0	7.0	0.84	0.38	0.89
....	....	....	....	....	....	1	3.0	7.5	0.80	0.37	0.91
....	....	....	....	....	....	1	3.0	8.0	0.76	0.35	0.93
1	3.5	5.0	1.11	0.59	0.85	1	3.5	6.0	0.88	0.46	0.80
1	3.5	5.5	1.06	0.56	0.89	1	3.5	6.5	0.83	0.44	0.82
1	3.5	6.0	1.00	0.53	0.92	1	3.5	7.0	0.80	0.43	0.85
1	3.5	6.5	0.96	0.51	0.95	1	3.5	7.5	0.76	0.41	0.87
1	3.5	7.0	0.91	0.49	0.98	1	3.5	8.0	0.73	0.39	0.89
....	....	....	....	....	....	1	3.5	8.5	0.71	0.38	0.91
....	....	....	....	....	....	1	3.5	9.0	0.68	0.36	0.92
1	4.0	6.0	0.95	0.58	0.87	1	4.0	7.0	0.77	0.47	0.81
1	4.0	6.5	0.91	0.55	0.90	1	4.0	7.5	0.73	0.44	0.83
1	4.0	7.0	0.87	0.53	0.93	1	4.0	8.0	0.71	0.43	0.86
1	4.0	7.5	0.84	0.51	0.96	1	4.0	8.5	0.68	0.42	0.88
1	4.0	8.0	0.81	0.49	0.98	1	4.0	9.0	0.65	0.40	0.89
....	....	....	....	....	....	1	4.0	9.5	0.63	0.38	0.91
....	....	....	....	....	....	1	4.0	10.0	0.61	0.37	0.93

Concrete with Stone 1 inch and under.						Concrete with Stone 2½ inch and under.					
Proportions of Mixture			Req'd for 1 c yd			Proportions of Mixture			Req'd for 1 c yd		
Cement	Sand	Stone	Cement Bbls	Sand c yds	Stone c yds	Cement	Sand	Stone	Cement Bbls	Sand c yds	Stone c yds
1	1	2 0	2.57	0.39	0.78	1	1	2.0	2.63	0.40	0.80
1	1	2.5	2.29	0.35	0.70	1	1	2.5	2.34	0.36	0.89
1	1	3.0	2.06	0.31	0.94	1	1	3.0	2.10	0.32	0.96
1	1	3.5	1.84	0.28	0.98	1	1	3.5	1.88	0.29	1.00
1	1.5	2.5	2.05	0.47	0.78	1	1.5	2.5	2.09	0.48	0.80
1	1.5	3.0	1.85	0.42	0.84	1	1.5	3.0	1.90	0.43	0.87
1	1.5	3.5	1.72	0.39	0.91	1	1.5	3.5	1.74	0.40	0.93
1	1.5	4.0	1.57	0.36	0.96	1	1.5	4.0	1.61	0.37	0.98
1	1.5	4.5	1.43	0.33	0.98	1	1.5	4.5	1.46	0.33	1.00
1	2.0	3.0	1.70	0.52	0.77	1	2.0	3.0	1.73	0.53	0.79
1	2.0	3.5	1.57	0.48	0.83	1	2.0	3.5	1.61	0.49	0.85
1	2.0	4.0	1.46	0.44	0.89	1	2.0	4.0	1.48	0.45	0.90
1	2.0	4.5	1.36	0.42	0.93	1	2.0	4.5	1.38	0.42	0.95
1	2.0	5.0	1.27	0.39	0.97	1	2.0	5.0	1.29	0.39	0.98
1	2.5	3.5	1.45	0.55	0.77	1	2.5	3.5	1.48	0.56	0 79
1	2.5	4.0	1.35	0.52	0.82	1	2.5	4.0	1.38	0.53	0.84
1	2.5	4.5	1.27	0.48	0.87	1	2.5	4.5	1.29	0.49	0.88
1	2.5	5.0	1.19	0.46	0.91	1	2.5	5.0	1.21	0.46	0.92
1	2.5	5.5	1.13	0.43	0.94	1	2.5	5.5	1.15	0.44	0.96
1	2.5	6.0	1.07	0.41	0.97	1	2.5	6.0	1.07	0.41	0.98
1	3.0	4.0	1.26	0.58	0.77	1	3.0	4.0	1.28	0.58	0.78
1	3.0	4.5	1.18	0.54	0.81	1	3.0	4.5	1.20	0.55	0.82
1	3.0	5.0	1.11	0.51	0.85	1	3.0	5.0	1.14	0.52	0.87
1	3.0	5.5	1.06	0.48	0.89	1	3.0	5.5	1.07	0.49	0.90
1	3.0	6.0	1.01	0.46	0.92	1	3.0	6.0	1.02	0.47	0.93
1	3.0	6.5	0.96	0.44	0.95	1	3.0	6.5	0.98	0.44	0.96
1	3.0	7.0	0.91	0.42	0.97	1	3.0	7.0	0.92	0.42	0.98
1	3.0	5.0	1.05	0.56	0.80	1	3.5	5.0	1.07	0.57	0.82
1	3.5	5.5	1.00	0.53	0.84	1	3.5	5.5	1.02	0.54	0.85
1	3.5	6.0	0.95	0.50	0.87	1	3.5	6.0	0.97	0.51	0.89
1	3.5	6.5	0.92	0.49	0.91	1	3.5	6.5	0.93	0.49	0.92
1	3.5	7.0	0.87	0.47	0.93	1	3.5	7.0	0.89	0.47	0.95
1	3.5	7.5	0.84	0.45	0.96	1	3.5	7.5	0.85	0.45	0.98
1	3.5	8.0	0.80	0.42	0.97	....	....	....	....	....	....
1	4.0	6.0	0.90	0.55	0.82	1	4.0	6.0	0.92	0.56	0.84
1	4.0	6.5	0.87	0.53	0.85	1	4.0	6.5	0.88	0.53	0.87
1	4.0	7.0	0.83	0.51	0.89	1	4.0	7.0	0.84	0.51	0.90
1	4.0	7.5	0.80	0.49	0.91	1	4.0	7.5	0.81	0.50	0.93
1	4.0	8.0	0.77	0.47	0.93	1	4 0	8.0	0.78	0 48	0.95
1	4.0	8.5	0.74	0.45	0.95	1	4.0	8.5	0.76	0.46	0.98
1	4.0	9.0	0.71	0.43	0.97	..	.	....	....	....	....

CONCRETE WITH STONE DUST FOR ARTIFICIAL STONE.

Proportions of Mixture			Req'd for 1 c yd			Proportions of Mixture			Req'd for 1 c yd		
Cement	Sand	Stone	Cement Bbls	Sand c yds	Stone c yds	Cement	Sand	Stone	Cement Bbls	Sand c yds	Stone c yds
1	1.0	2.0	2.51	0.38	0.76	1	2.0	4.0	1.44	0.44	0.88
1	1.0	2.5	2.27	0.35	0.86	1	2.5	4.0	1.33	0.50	0.81
1	1.5	2.5	2.00	0.46	0.76	1	2.5	5.0	1.18	0.45	0.90
1	1.5	3.0	1.83	0.42	0.84	1	3.0	4.0	1.23	0.56	0.75
1	2.0	3.0	1.65	0.50	0.75	1	3.0	5.0	1.10	0.50	0.84

The weight of dry concrete is from 130 to 160 lbs to cf. A fair average is 145.

A stone crusher costs from $700 to $2,000 and crushes 6 to 7 cy per hour with 10 to 12 men, and an engine of 8 to 10 h. p. A car-load of cement runs about 170 bbls.

The results of some interesting experiments were published in The Railroad Gazette of April 11, 1902. They may be of use to those who want accurate figures for the proportions and weight of concrete:

Per cent of voids: Sand, 25; gravel, 32; stone, 44. Weight of material per cf: sand, 102; gravel, 98; crushed stone, 84; cement, 88.

In these experiments 4 sacks of cement measured loose 4.42, or practically 4.5 cf. The packed bbl does not have so many cf—from 3.5 to 3.8—as the loose, and herein lies a basis of dispute between the men of theory and the contractors. The theorists want the proportions to be taken from the measurement of the packed bbl, and the contractors naturally want the cement to be measured loose like sand and stone. Good cement is saved by this method; why waste it? The courts have sometimes had to decide the matter. Sand, we are told, shrinks from 7 to 10% when wet, but we hear no cry for packed sand. If one why not another? The committee already quoted was content with 10% at most, but some authorities tell us that owing to this shrinkage the cement paste should be about 50% in excess of the voids of the sand, and that the mortar of cement and sand should be about 50% in excess of the voids of the stone. If the Gazette's figure of 25% void is correct, the allowance of .4 which is given in the examples worked out is sufficient,—and the rest may be filled with pure sand until the theorists give us a figure upon which they all agree.

Another part of the same number dealing with proportions says that cement 1, sand 1, and stone 2 make as good a concrete as can be made with natural cement; while 1, 2, 4 to 4½ is as poor as good practice will permit. Portland at 1, 3, 6 "is sufficiently good for ordinary construction;" 1, 4, 8 for plain work.

The cement mills could not turn out enough material to supply the demands of 1902, and the future is likely to witness even a more extensive use of concrete. In the U. S. the production of natural cement

is from 8,000,000 to 9,000,000 bbls,—in 1902, about 9,600,000. The following figures showing the production of Am. Portland only are worthy of note:

Year	Barrels	Year	Barrels	Year	Barrels
1882......	85,000	1890......	335,000	1898......	3,692,284
1884......	100,090	1892......	547,440	1900......	8,482,020
1886	150,000	1894......	798,757	1901......	12,711,225
1888......	250,000	1896......	1,543,023	1902......	20,864,078

A large number of 1½″ holes were drilled in the hardened concrete of No. 7 to hold the steel cols. They are 29″ deep, and 2 men with a hand drill cut 7 in a day. Some at 23″ were cut at the rate of 10 per day.

The water-table of No. 7 and the other buildings of the plant is made of concrete cast in a form. It costs about 40c per cf. Stone costs $1.25 and upwards. The concrete runs clear through the wall and takes the place of the brick, while stone is usually only 8″ wide. The setting cost about 13c per cf, but stone also requires to be set. Labor was .20, sand .01, stone .05, cement .10, or a total of 36c, but a leeway of a few cents is desirable. Of course a small quantity would cost more, as the same forms are required for 100 ft as for 1,000; and angles require more labor than long straight walls.

The water-table was a complete success, hard as a rock and as smooth as the boards on the inside of the forms.

We have republican and democratic waves, conservative successes and liberal triumphs in the political field; and it sometimes seems that waves come in building as well as in other spheres. One of the first jobs I got as an apprentice was to put up 2 long lines of studs covered on the inside with boards about a foot apart. Then the concrete was poured in and the finished wall appeared after the boarding was taken away. About the same time, in the same place, a stone contractor became tired of stone and took to concrete for everything,—door and window sills, mouldings, and the walls of his buildings clear to the roof. But stone still survives.

Now we are in the midst of another revival. Stone, in spite of machinery, has risen to a high price, and builders begin to look around for a substitute. They find it in concrete and terra-cotta, and if properly used both serve as a check on the stone-mason. The danger is that concrete will be put to unwarranted uses. Concrete piles are made. If it goes too far something will "drap," and then the authorities will become so unreasonably suspicious that they will not use concrete in places where it is better in every way than any other material.

Since writing the foregoing paragraph I have seen a description of a 7-story building now going up in Milwaukee. It is of cement throughout. Above the 2nd story there will be neither wood nor iron except the sash on one front. "The girders will be solid beams of concrete, cast upon the premises as required." It is attracting unusual attention among builders.

Developments come so fast in our day that one paragraph is no sooner finished than it is time to begin another. In May, 1903, I saw a picture of a 16-story building being erected in Cincinnati for the president of

"The Big Four," and with the exception of some stone trimmings it is wholly of concrete.

CONCRETE FLOORS

On No. 2 there were 1,150 sq yds of floor with a 2″ concrete base and a ½″ top-dressing. The base was 1, 2, 5. Without the top-dressing there were 64 cy. A 6″ bed of cinders was first laid down, watered and tamped. MATERIAL:—100 bbls American and Imported Portland. I did not keep an exact account of the stone, but the ordinary rules for concrete will give the quantity closely enough, say, 75 tons. Sand about 32 cy. Labor was 35c an hour for 1 man, and ordinary wages of $1.50 to $1.75 for laborers. The labor ran to $300; cement, $345; stone, $82.50; sand, $22, a total of $748.50, or close to 66c per sq yd. There is nothing allowed for tools, hose, etc, in this or the other concrete figures.

By the sq yd, sand and stone were 10c; cement, 30c; labor, 26c. This price is too close to figure on with safety, as accidents sometimes happen. Of course, 2″ thick does not take so much material as 4.

For a floor of this kind 5″ thick, the usual allowance is $1 to $1.25, depending upon wages, price of cement, etc. All the cement walks around No. 9 were laid for $1.35, and the price was low as cement was $2.75 per bbl. In spite of the high price of the imported cement the floors of No. 2 went down reasonably cheap. The labor included the wheeling of rubbish and the tamping of cinders. One bbl of cement laid 100 sq ft; but that was for only 2½″ thick. A trade publication at hand gives 1 bbl to 75 sq ft.

But again I know of a small building erected in Omaha in 1902 where 6″ floors cost about $1.70 per sq yd. Gutters had to be formed in several places, and special work of that kind soon runs into extra time.

It is easy enough to estimate floors, sidewalks, etc, of a special thickness, as we have only to get the number of cy and add the top-dressing. The dressing is sometimes 1 of cement to 1 of sand in the specification, but seldom in the floor. It is easy enough to get at the number of cy in the dressing, and the quantity of cement can be found at 4 cf in a bbl. The labor on dressing will run to about 14c per sq yd at the rate of wages given for No. 2. Of course the labor on a thin floor of 2″, for example, is more in proportion than for 4 or 6. The same leveling and top-dressing have to be done in both cases.

Cement base: A cement base about ⅝x10″ was formed all through the basement of No. 2. The price ran to about 12c per lf, I think, although no record of the time was kept. But a contractor would not take such a base for less than 18c, including his profit,—and on small rooms 20c would not be too much.

CHAPTER IV.

STONEWORK

RUBBLE

MEASUREMENT:—Measurement is taken only by the cf or cy. Perches and cords are out of date.

Rubble is often measured by counting the corners twice, and making no deductions for openings, just as with brickwork. Here we shall abide by net measurement so that an accurate bill of material can be taken

directly from the original estimate, no matter how many or varied the openings or corners may be. It naturally takes a little more raw material for angles than for straight work, but this does not count enough to justify the old style of measurement. Even when a wall is less than 16″ thick it is best to take the actual contents and allow extra for labor.

QUANTITY:—Allow 2,900 lbs of stone to the cy of masonry in the wall. The owner of a Nebraska quarry writes me that his railroad customers say that it takes from 3,000 to 3,200 lbs. An Omaha mason gives the same figure. Something depends upon the stone. Thin stone with more joints make up in mortar for less weight required. "On small stones about $\frac{1}{3}$ of the mass will be mortar; large stones $\frac{1}{5}$ to $\frac{1}{4}$." The C. & N. W. R. R. finds 2,700 lbs enough for a yd in the wall, but the stone is of good quality. The ordinary Chicago allowance is 13,000 lbs to 128 cf, or 2,742 lbs to the cy of finished wall.

Good work requires what is colloquially known as "2-man rubble,"—that is, stone too heavy for 1 man to lift—"1-man rubble" is fit only for cheap work. It would not be accepted on government buildings. The raw material is worth about 50c per cy less than the other.

As with sand and crushed stone it is almost obligatory for a contractor to take rubble by weight instead of measurement on account of freight and hauling charges; and it is therefore worth remembering in case a specification calls for granite or some specially heavy stone that an extra allowance would be necessary. Granite or limestone runs at least 20 lbs heavier to the cf than sandstone, but granite is seldom used for rubble.

The proportion of mortar given by one writer is to coarse rubble not dressed, 33 to 40%; roughly dressed, 25 to 30%; well dressed and coursed, 15 to 20%. With stone at 150 lbs to the cf, allow 2,700 lbs in the first case, 3,040 in the second, and 3,440 in the third.

For ordinary work Trautwine allows 6 at the quarry to 5 in the wall. The proportion of 128 in the quarry to 100 in the wall is often used, and on 400 or 500 cy was recently tested in Omaha with satisfactory results. In case stone is not bought by weight this will serve as a measure of quantities. According to the same authority 1 cy of stone when broken occupies 1.9 cy when perfectly loose, or 1.75 when piled up.

PRICE:—From $4.50 to $6 per cy. Midway is a fair price for ordinary work in Am. Portland with wages at 45c to 50c. The heavy wall that runs around the west side of the Omaha post-office was let to the contractor in 1901 for $6, but this included his profit. It is laid in cement and is an excellent piece of work. There are no angles to speak of, and no openings, but a straight wall about 2′ thick.

Engineering work of a certain class costs more. Embankment and abutment walls faced with squared limestone filled in behind with dimension stone undressed run here, hauling included, from $9 to $10 per cy all through. But the face stone, if taken alone, is worth per cf close to 70c. Small piers squared all around run to 75c per cf. Some local work of both classes has recently been done at these figures with Nebraska stone which costs 25c on cars, but profit is included. If Bedford or Kasota stone is used the price is increased, as the raw material

is worth 50c. A cheaper Bedford stone can be used for this work than for buildings.

The limestone masonry in the piers of the bridge across the Missouri River at Plattsmouth, Nebr.—1879-80—cost the R. R. Co. $18.60 per cy exclusive of freight, engineering expenses and tools. The small piers ran from $12 to $14. Work of this kind would be better classed under cut stone than rubble.

"One-man" rubble FOB Omaha or Lincoln, about $1.10; "2-man," $1.20 per ton.

There is little rubble used in this territory. It is safe to say that for one foundation of stone there are 99 of brick, usually with a concrete footing. Thus it is that our surroundings change. During a long apprenticeship of 5 years and for 1 year afterwards as a journeyman I worked on and saw all kinds of buildings and never, so far as I remember, lifted a hammer on a brick one. Everything, except inside partitions and a few factories, is of stone in the town of Kirkcaldy, with a population of 20,000 people, and there are no anchors on the joists. The walls are built thick enough to stand. The walls of the 1-story cottage I lived in near that place are 30″ thick for an 8′ ceiling. Like a man with big feet such buildings would stand although they were shot.

It is seldom that a building contractor has to line a slope with stone, but the following figures from "The Engineering News" of June 11, 1903, will be of interest. They are taken from actual records. The maximum thickness of this kind of work is 10″ to 12″; minimum, 3″ to 4″. Stones must be 12″ long. Average joints are $1\frac{1}{2}$″; if $\frac{1}{2}$″, the labor costs twice as much. Mortar is not used. With $1\frac{1}{2}$″ joints, 750 cy of 12″ were laid, each laborer laying $2\frac{1}{2}$ cy per day at the beginning, and 3 later on. Skilled men were then employed and laid 5 cy with 1 laborer to 4 tradesmen. Part of the work was then sublet at 50c per cy to men who had been laying 5 cy; from that time on they laid 7. On rougher work skilled men sometimes lay 10 to 12.

On another contract 4 masons and 4 laborers averaged 60 cy in 10 hours. With material delivered at $1.25 to $1.50 the finished work is worth $1.75 to $2. The time at quarry for 280 yds was 1,000 hours to quarry and load; this made 220 cy in the wall. The teamsters hauled 4 to 5 loads in a day, a distance of $2\frac{1}{2}$ miles. Team traveled at rate of $2\frac{1}{2}$ miles per hour.

On another contract with 750 cy 6 trips were made a distance of $1\frac{3}{4}$ miles.

MORTAR:—The quantity of mortar required depends upon the quality of the work and the size of the stone. Thin stones naturally require more than large blocks. Taking the figures already given, 33, 25, 15% of mortar we may easily arrive at the quantities for the various proportions. Taking cement packed we have in Am. Portland about 7 bbls to the cy. For a cy of cement mortar allow as follows,—the figures for cement being in bbls, and for sand in yds:

1 to 1, 4.2 cement to .6 sand; 1 to 2, 2.7, .8; 1 to 3, 2, .9; 1 to 4, 1.7, .95; 1 to 5, 1.3, .97; 1 to 6, 1.2, .98. But it must be remembered that when cement reaches a certain point of weakness it will not work, and

what is gained in material is more than lost in wages. But again, a mortar of 1 to 3 is about as strong as we ever make, no matter what is specified; 1 to 1 is unreasonable considering that the rivers and the hills are full of cheap sand—and except for coping of walls and such work it is not really necessary.

Let us choose for illustration a coarse undressed rubble with 33% of mortar—and if filling is not properly done with small stones a careless mason can easily throw in $\frac{1}{3}$ of the mass in mortar. Taking 30 cy we require 10 cy of mortar. At the proportion of 1 to 3 this means 20 bbls of cement and 9 yds of sand to 30 cy of masonry.

At 1 to 5 for the same quantity of masonry 13 bbls and 9.7, or practically 10 cy of sand.

Or taking the second class of masonry which is better than the average, we have 25% or $\frac{1}{4}$ of the total in mortar. For 4 yds of wall we therefore require 1 yd of mortar. At the proportion of 1 to 4, which is of fair quality, 1.7 bbls of cement require close to 1 yd of sand. In 4 cy we have 108 cf, so that for average work allow $1\frac{3}{4}$ bbls and 1 yd to every 100 cf of finished wall. A yd of sand to $3\frac{1}{2}$ cy is an Omaha allowance; and $\frac{1}{2}$ bbl of cement to 1 yd of rubble.

LIME MORTAR:—Lime makes $\frac{1}{4}$ to $\frac{1}{5}$ more mortar than cement as it swells when slacked; for this reason the cement quantities require to be cut down. Some allow $\frac{1}{4}$ bbl to cy,—$\frac{1}{3}$ is safer. Trautwine gives 2 bbls to 100 cf, but this is too much unless the stone is thin and small. But again, we run across lime that does not seem to make more than $\frac{3}{4}$ of the mortar produced from the best brands. On several buildings a careful account of mortar was kept, and at our prices cement was 65c and lime 55c per cy of wall. For making rubble mortar the Omaha Water-Works Co. charges 8c per cy for water; for tempering only, 3c. The meter rate is 35c per 1,000 gals which is far cheaper,—say $\frac{1}{3}$ the price. The Chicago rate is 6c for 128 cf.

LABOR:—A mason and laborer will lay 3 cy of ordinary rubble in an 8-hour day; and on some kinds of walls below ground, 5 to 6. One laborer can attend 2 masons if everything is handy, but if wheeling is required it takes about man to man. In the stone-cutting yard 2 men can attend 10 cutters.

On a building recently erected 500 cy of rubble cost about $1,000 for labor. Most of the stones had to be handled with a derrick, and although the walls were thick and straight this cost probably 25c extra. On another building with 120 yds the walls were short and the cost ran to $2.50, but extra time was required on the angles. Good time can be made with a derrick if all the stones are large, but if work is so far away from ground that large and small have to be handled this way it costs more. A fair price for 18 to 20″ ordinary work is $1.50. Thick, straight walls can be done for less. The labor is not exactly in proportion to the number of cy, as a 16″ wall requires 2 faces just as a 24″ does; and the filling goes in faster than the outside work. Scaffolding has sometimes to be allowed if walls are high.

In 8 hours 1 man will cut and square about 40 cf of large limestone blocks for bridge and pier work, and 25 of small blocks. Sandstone

costs more to cut than limestone as it wears out the tools sooner. Unless very soft it is worth 10% more to square up. There is no sandstone in Bedford, Ind.; "Bedford" is a limestone.

GRANITE:—Granite rubble would cost about 3 times as much as limestone here, and is consequently never seen. The following figures are culled from the appendix of Baker's work on Masonry—and he culled them from the official reports. In case of emergency they will give a fair idea cf the labor on granite.

In quarrying rough stone allow for 1 man 8-10 of a day per cy; stone to be cut for facework, 2.6 days.

On more than 2,000 cy near New York it was found that the average time of a cutter for 1 cy was 36 hours. The work was all cut into headers and stretchers—2′x3′, and 2′x6′ with a rise of from 20″ to 26″. Round coping required more work; the average per cy was 50 hours for 1 man. Keystones, springers, etc, 56 hours. But these figures include moving stone, sharpening tools, superintendence, etc. Superintendence was 5%; sharpening tools, 15; interest on sheds, derricks, etc, 1%; new tools and timber, 1%, or 52% in all, which added to the total wages gives the complete cost. It is thus seen that half the cost is outside of cutting proper.

On another contract a minimum day's work was set at 12 superficial ft on a total of 118,383 cf; but the average for beds and joints reached 13.6′ per man per day. The average ran as follows:

Beds and joints	13.6 super ft
Pointed work with margins	8.5
Peen-hammered	6.15
6-cut patent-hammered	5.22
8-cut patent-hammered	4.24

On the Croton reservoir a minimum day's work of joints was fixed at 15 sq ft for 1 man, but with draft around the edges this is equal to 17.7 sq ft.

The average day's work in cutting beds to lay a ¾ joint was 18.7 sq ft. In these last 2 items add for superintendence, 8%; sheds and tools, 7%; sharpening tools, 11%; labor moving stone, 10; drilling off rough face, 4; making a total of 40% to be added to cutting.

The finished work of the new Omaha post-office, moldings included, is said to cost $3 per cf FOB, cars.

ASHLAR AND CUT STONE

MEASUREMENT:—Take the exact cubic contents of a wall and order the stone from the quarry on this basis. The quarryman allows for waste in cutting. If 100 cf are ordered the block is sent large enough to be squared to this size. With such a stone as Bedford there is little chance of waste if sizes cut to advantage. The ordinary method of measurement allows openings under a certain size, doubles angles and so forth, but "The Building Estimator" in general is not based upon this old system. In rock-faced work allow 2″ extra for projections beyond the face of the wall; if the stone rests 8″ on the wall this means 10″ material. Projections are usually about 1″, but a margin has to be allowed for safety.

PRICE:—Bedford is delivered FOB Omaha for 68 to 70c per cf. Blue and buff are commonly used. Blue is better than buff. There is a hard Royal Blue which costs the same, or a trifle extra, but is about 20% more expensive to cut. It is used for long lintels, steps, etc, as the common Bedford is too soft.

The cut stone over an average building may be taken as $1.40 per cf, but something depends upon the state of the yards. In busy times $1.50 is asked. These figures include the contractor's profit, but not setting which is worth about 20c extra, and 5c for pointing, or 25c per cf.

On an Omaha house finished in 1903, with about 16,000 cf of broken ashlar from Silverdale, Kan., including moldings, battlements, turrets, and all stonecutting, 3 contractors allowed from $1.45 to $1.50 per cf set, but another got the contract, so that his price is lower. The raw material FOB Omaha cost about 50c per cf.

On a library built in eastern Iowa in 1902 there were 16,000 cf of Bedford stone estimated by the successful contractor at $25,000 set in the wall. After deducting about $4,000 for carving, the complete job was only $1.31 per cf which is too low. Freight is, of course, lower at that point than here.

Another library—the one now going up in South Omaha—was estimated at about $1.90 per cf set.

The Commercial Nat'l Bank, Omaha, was estimated set at $2.25 by an unsuccessful bidder; it was probably done for about $2. But better prices were obtained when it was built. As it is polished, the rate would now be lower on account of saws. But rubbed work is worth about 20c per sq ft extra if straight; and 35c if circular. If more than 1 side is finished the cost is naturally increased. If coursed or range work is used instead of broken or random ashlar, 20c per cf may be deducted. The setting is much easier.

But ashlar is usually taken by the sq ft instead of by the cf. The price depends upon the number of openings and the size of the reveals. If they are 8″ the stone must be much thicker than if 4; and if openings are close together a thinner stone can not be much used between. Rock-faced of average thickness is worth $1 to $1.25 broken in "Crazy Quilt" fashion; 90c broken but squared; and 80c coursed from 8 to 12″ high in 4 and 8″.

All of the foregoing figures are based on Bedford stone. The setting and pointing are not included. The setting of broken ashlar costs about 15c per sq ft. On a large, straight job without delay 10c is enough, but residences with waiting on bricklayers, etc are worth about 20c.

CUT STONE

For Bedford water-table, door and window sills, courses, bands, and in general the whole of the cut-stone bill on an average brick building, allow $1.50 per cf delivered either on the cars or at the building in cities like Omaha and Lincoln. But when there is an excess of moldings, pediments, carving and so forth, care must be taken to make a due allowance.

The large 4″ flagstones around No. 3 were laid complete for 37c per sq ft; 4″ is now worth 35c laid; 6″, 60c. Saws now reduce the price al-

though wages are higher. If laid on I beams allow 8 to 10c extra per sq ft, as laying is more difficult. No. 2 stone is used.

MORTAR:—The backing of ashlar, whether brick or rubble, requires the common allowance of material given under these headings. With courses 8″ high less mortar is necessary than with common brick; and when the courses are 18″ and of a proportionate length it is clear that the quantity of mortar is decreased. In such a case make a reasonable deduction from the allowance.

"With $\frac{3}{8}$ to $\frac{1}{2}$ joints," says Baker, "and 12 to 20″ courses there will be about 2 cf per cy; with larger blocks and closer joints 1 cf of mortar to 1 cy of masonry. Laid in 1 to 2 mortar ordinary ashlar requires $\frac{1}{4}$ to $\frac{1}{3}$ of a bbl of cement per cy of masonry,"—but 1 to 2 is seldom used except in specifications. Cement is too valuable. A given number of cf of mortar being determined for a yd of finished work it is easy by referring to the rubble table to allow cement, lime and sand according to the proportion desired; and lime it will be remembered makes more mortar than cement.

Another authority says that ashlar in courses of 20 to 32″, and joints of $\frac{1}{4}$ to $\frac{3}{8}$, will have from 5 to 6% of mortar. With ordinary rubble running from 25 to 33% of mortar it is evident that the outside facing of the wall requires less than the backing, and deductions should be made where nicety is required. Nicety is not usually required, but the advantage of remembering the decreased quantity for the facework is that when the general bill of material is made out the usual allowance is cut.

LABOR:—Since the introduction of saws rock-faced work costs about 10% more than plain-faced. With hand labor it is cheaper to make rock-faced sills, water-tables, etc. But before a tool is lifted rock-faced work requires 2″ more in thickness, and stone has to be paid for. Other things being equal, in the neighborhood of saws use plain work; in the country make it rock-faced.

With saws and molders labor is reduced to $\frac{1}{2}$, and in some classes of work to $\frac{1}{5}$, of its former price. By hand a mason will cut about 20 sq ft of broken ashlar in 8 hours, and 25 of coursed; but when saws are used it is cut to thickness and then merely pitched by hand, so that 100 ft can be done. Polished stone is even cheaper, and a man can joint and prepare 125 sq ft. For plain cut stone allow 25 to 35c per cf for labor. Finials, capitals, carving and such work must be allowed separately in addition to the regular price. There is no set rule for estimating special work, as no 2 pieces are alike. The amount of labor must be judged and added to price of stone. And accidents happen: I once saw a splendid finial cut for a Gothic church. It was about 6′ long, and the foreman did all the work himself as he could not trust the best of his men. After the carving was done he mounted a trestle and started to drill a hole for an iron rod. When he got down about 2′ the drill came out at the side.

Gothic tracery lies at the Back of Beyond so far as this happy state of Nebraska is concerned. The straight mullions would not be hard to price, but the trouble lies above the spring. I have looked upon too much of this grandeur in Europe and the East to care to let any one

know my system of estimating it. There are some things that a man is justified in keeping to himself. A distinguished French literary man once said that there are expressions in his language so difficult that he always took a long circuit around rather than meet them—and most estimators feel the same way about tracery.

Sunk letters from 4 to 6″ high are worth from 50c to 70c each; raised, 75c to 85c. Holes for iron railings, 10c; leaded, 5c to 6c per lb for lead.

Hauling from cars, say 1 mile, 50c per ton. As a full load is 2 tons this means $1 per load, which is the Omaha allowance under ordinary circumstances. But loading and unloading are the same for any given haul.

See Chap on "Municipal Work" for price of curbing.

Washing and pointing all the smooth surf of No. 3, laid in a hard Wyoming stone, cost 1.6c per sq ft, but the blocks were large. This is too low a figure to use for work now, especially with broken ashlar and short runs. Bids were recently made to wash and point a building for 2½c; and another building was figured at 3c. The joints have to be raked out, pointed, and then the whole surf washed. A fair price is 3c after openings are deducted. The openings of No. 3 are included in the surface.

La Farge cement is often specified for stone-setting as it does not stain the stone. It costs about $7 a bbl. Gare au loup!—which in the vulgar meaneth, Look out for the wolf.

CHAPTER V.

BRICKWORK

MEASUREMENT:—Some years ago the Omaha masons issued their rules of measurement which were practically the same as those of St. Louis and Chicago. They are excellent rules in their way,—but I should not like to be an owner and let my work to a contractor by the 1,000 at a high price, especially if it consisted of angles, pilasters, ledgings and so forth. When estimating a building few brick-masons pay any attention to the printed sheets of former years, which most of them have probably forgotten. It would merely fill up space to print them over again. The system followed in this book is the same as for stonework;—take the exact cubical contents, but allow "wall measure," or 22½ bricks to the cf.

In the Chicago building code there is an explanation of the rules to reassure the public. Cornices, pilasters, projections, and so forth cost much more than plain work, and instead of charging a higher price for each piece separately the charge is simply made in the measurement. It is easier to estimate a building on this basis and it is just as fair, for the rate per 1,000 would be greater if openings were deducted and cornices measured as plain work. But while this is true in theory most contractors now cut out openings and take actual contents. Competition is too keen to do otherwise. I prefer this method because the bill of material can be taken directly from the original figures without a new calculation to see how many feet windows, corners, cornices, etc make up. Buildings differ so much in their openings

and other features that it seems best to take only the actual contents of the wall and allow so much more per 1,000 for difficult work.

But there is a trade way of estimating the brick in a wall that all contractors use, and it requires a word of explanation: The method does not give the number of actual brick required, but the number in "wall measure," which is different from actual or "kiln count." It is merely a trade rule, a short cut, a labor-saving device, and involves neither treachery to the state nor robbery of the individual citizen.

The Omaha rule is the same as that of Chicago:

Every	superficial	ft of	$\frac{1}{2}$	brick	thick	shall	count	$7\frac{1}{2}$	bricks
"	"	"	1	"	"	"	"	15	"
"	"	"	$1\frac{1}{2}$	"	"	"	"	$22\frac{1}{2}$	"
"	"	"	2	"	"	"	"	30	"
"	"	"	$2\frac{1}{2}$	"	"	"	"	$37\frac{1}{2}$	"
"	"	"	3	"	"	"	"	45	"

It all depends upon the size of the brick. It is possible to make them to fit the foregoing table, but it is not done, and thus the rule is a rule of thumb and not a rule of science. But it works, and it is hardly worth while trying to change it.

The building ordinances now get the thickness of a brick wall mixed up. Sometimes it is even and sometimes odd—8, 12, 16, 20, 24, and so on, adding 4″ at each advance. Again it is 9, 13, 17, 21, 25, 29, adding as before but starting on another basis, which, after all, is nearer the exact thickness. The Omaha rule gets over this and avoids figures which change with the different makes of brick. We have $\frac{1}{2}$ brick, 1 brick, and so forth, and for every $\frac{1}{2}$ brick additional $7\frac{1}{2}$ are added. A wall 9″ thick has 2 brick in width and 15 to the sq ft.

According to the table, $22\frac{1}{2}$ brick are required for a cf. As a matter of fact 17, with large joints, are enough of the national size, which is becoming the standard,—$2\frac{1}{4}$x4x$8\frac{1}{4}$″. The contractor is not paid for the larger number, for competition is keen enough to prevent this. When making up his bid he does not estimate the full labor and mortar separate from the brick, and the difference between wall measure and kiln count goes for these items, along with a certain allowance of money.

In some localities the advance is made by 7 instead of $7\frac{1}{2}$, but what is the advantage? A cf of wall does not require 21, so that kiln count is not found. Even 6 are usually too many, and besides, a new calculation would have to be made for mortar which would mean extra labor. An estimator never troubles about mortar until the contract is signed. And if the method of the outsider were followed, if the exact number had to be obtained, how would he proceed when the brick were $2\frac{3}{4}$″ thick instead of $2\frac{1}{4}$″? He would have to obtain the number to the cf. The trade rule is safe with any size.

A convenient multiple is also found in $7\frac{1}{2}$, because with 15 and 30 and the ease with which the intermediate figures are turned to decimals, it is better than either 7 or 6.

Most of the short cuts in arithmetic we learned at school are forgotten because we never use them,—one I remember because I use it

continually in estimating brickwork. Take a 9″ wall, or 1 brick thick, 100′ long, 12 high. This means 1,200 sq ft, which at 15 brick equals 18,000 in wall measure. Instead of multiplying by 15 it is easier to add a cipher to the 1,200, or any number of sq ft, put the half below and add the 2 together. It is easier to mult by 30 than by either 24 or 28, multiples of 6 and 7.

A few examples may give a little more confidence to those who have never figured brickwork: A wall 200′x20 high, 2 brick or 17″ thick, contains 120,000 brick in wall measure; 130x13x9″, 25,350; 40x18x3 brick, or 25″, 32,400.

Of course, it is necessary to remember that too much nicety is out of place when estimating a large building. A cornice or footing is not to be taken by little 2″ offsets and the exact contents found; a fair average is all that can be expected. It is often easier to estimate a footing by standing it on edge, as it were, and treating it as a wall of a certain thickness. If this will not work take the number of cf and mult by 22.5. But it may be worth while observing here that a wall marked 13″ on the plan counts only as a ft. Some architects mark their walls 12, others 13. It is, of course, only odd work that we need to reduce to cf, because the number is given for all standard thicknesses in the regular table.

Following the illustrative method of this book we shall now take a glance at No. 2. The actual wall measurement with openings deducted, corners and half intersections not counted, pilasters taken on face only, and so forth, was exactly 1,000,000 brick. The actual quantity required was 750,000. The brick were of the national size. The proportion stands at 4 to 3, so that a cf at 22.5 wall measure all through that building required practically 17 brick. This is a better guide than any theoretical tabulation. With a larger brick 16 would be enough; and a building recently put up with 76,000 kiln count, at 2½″ thick, required only this number. In engineering work with large brick and heavy joints, 15½ are sometimes sufficient, but this is at the danger limit. On No. 8, and other buildings of the plant, there were 2,300,000 in wall measure, and the contractor used 1,650,000, or a trifle less than 16¼. This included waste.

The number of brick on my original estimate of No. 2 with ½ the openings deducted was 1,090,000. If estimated according to the standard rules of Omaha and Chicago, with large chimneys solid, the number would be about 1,190,000.

The size of the brick has to be watched both on account of quantity and labor. Small brick are not much loved by contractors. The national size is making its way, but some manufacturers still adhere to the old large sizes in spite of building ordinances, which forbid under penalty of fine, anything larger than 2¼x4x8¼. The size listed in the Chicago ordinance is 2x4x8.

Straight walls are easy enough to estimate, but pilasters, cornices, chimneys, and such work require more care. A pilaster with 4½″ of projection is really a wall with 7½ brick to the sq ft; and all other projections are taken in the same way. A cornice is often as simple, and

when there are many offsets, a fair average section can be taken. No contractor would think of deducting the hole of a small chimney, even if he followed the system of taking only the actual contents of a building. Special work of this kind is like fitting the last board of a floor to the wall: it takes 10 times longer than a board in the middle of the room, but the general average must be made high enough to provide for it.

The question of waste requires to be noted. It is placed from 2 to 5% by the authorities. With fair brick, 2 is sufficient; only the poorest material should run to 5. But the waste in Nos. 2 and 8 is included in the number used, so that the proportion stands.

Estimate hollow walls the same as solid walls of equal thickness, and allow $1.50 per 1,000 extra when both walls are 9″; $1 when both are 13.

Deduct the thickness of ashlar and figure brick backing by the ordinary rules. Sometimes a little fitting has to be done against the stone, but there is no exposed work or plumbing of corners. Brick nogging in between partition studs takes about $\frac{1}{2}$ more time than straight work.

Nos. 2, 7, 8, and 14 are laid in shoved work, with a selected common face-brick and a $\frac{3}{8}$ joint,—which occasionally stretches to $\frac{5}{8}$ without any harm being done. Work of this kind if well laid is worth $1 per 1,000 more than the usual quality.

It may be well to point out here a trap that snared at least one Omaha contractor. Cheap brick have to be watched. Times were dull and he got his brick for $5 per 1,000, but he got something else with it—he got left, if we may employ an idiom that held sway in Athens in the age of Phidias, Pericles, or some hero abler than both together:

Take as an illustration a building with 1,000,000 brick, wall measure. Allow 750,000 kiln count and put the price for laying and mortar, say $2.50 per 1,000 wall m extra. No matter what the price of brick this cost is a fixed quantity. If you got brick for nothing the laying and mortar would cost the same as if they were $20 per 1,000. With brick at $5 the contract runs to $7,500; at $7, $9,500. In both cases 750,000 kiln count are required, leaving a balance of 250,000. This quantity in wall m is not required, and the allowance goes for mortar, laying and profit, coupled with the $2.50 extra on the 750,000. After buying brick at $5 the balance is $3,750; at $7, $4,250; or on the basis of the 250,000 at $7 we get $1,750, while at $5 the amount is only $1,250, leaving a shortage of $500 for laying, mortar, and profit, which are the same regardless of the price of the brick. With dear brick and wall m there is a sure margin if the same $2.50 or $3 are added.

A common figure for ordinary brickwork is $10 to $11 per 1,000 when brick cost $7 laid down; but a good deal depends upon the size of the building and the character of the work. A small Omaha building laid in Portland cement cost $12.50 per 1,000, wall m, with 1902 wages of 55c. Even large ones have been known to run to $16.

Underpinning and such work costs a good deal more than plain walls. On one building the cost of labor on 180,000 brick, kiln count,

was $9. All the work went under a raised roof and in openings and required extra labor outside and inside. But work at that price is worth watching. Some small basements have run as high as $25.

Brick walls 4½″ thick are seldom built here; in Scotland I saw them in almost every house. They are used for partitions on the first floor, and if properly built and plastered they last for a lifetime and beyond. But the labor costs at least 10% more than if the walls were thicker. If built here by the average bricklayer I should be afraid to lean against them. The Arabian proverb says that hurry is the devil,—but again, what can be more leisurely than $9 to $25 per 1000 for labor? Two new brick schools have been torn down in Omaha in recent years; at least one more is falling to pieces. There is plenty of brickwork in Europe hundreds of years old, but it was laid by men who understood their business, just as the old-style American carpenter understood his a century ago and built frame houses that still endure.

SEWERS:—See Chap 6.

CESSPOOLS & CISTERNS:—Cisterns are often taken by the bbl at about 85c. This includes excavation, 4″ brick lining on bottom and around arch, a finish coat of Portland cement, and an iron cover.

Or the work may be estimated in the ordinary way; mult the internal diameter by $3\frac{1}{7}$, the product by the hight, and the number of sq ft by 7½ for wall measure. Add floor, arch and ring. If walls are thicker than ½ brick proceed as explained under sewers. The labor of laying brick against earth is about same as on an ordinary wall, for there is no plumbing. The turning of the arch takes some extra time. For an 8′ span, ½ brick thick, allow 1 man 5 hours at most; for 10′, 6 to 7.

Cesspools cost more for labor as they are deeper, and both excavation and scaffolding are more expensive. Cisterns are usually about 10′ deep,—cesspools may be 20. Add 25% for labor.

Cost price of cesspools lined with 4½″ of brick in cement, and plastered with Portland may be approximated as follows: 4′ inside diam $3.25 per ft deep down to 12′; to 20′, $3.75: 5′ diam, $4 and $4.75 for 12 and 20′: 6′, $5 and $6. Or roughly, $1 per ft of internal diam per ft deep—4′-6″ diam, $4.50 per ft deep.

BOILERS:—There are so many kinds that it is hard to set a price. Get the number of cf and allow from 25 to 50% for extra labor. But if set upon large foundations without other masonry the unit price need not be greater than for ordinary work. Cost may run from $200 to $600.

CHIMNEY-STACKS:—Get the cubical contents of wall, then actual number of brick required, and estimate $10 per 1000, at 55c per hour basis, for labor. Above 100′, $12 up to 125. Allow sand and cement or lime in ordinary way. If core is too small for men add scaffold. Allow extra for fire-brick if used. When bricklayers get 75′ above the ground they usually demand higher wages, and often reach $1 per hour when 100′ high. But on basis of 55c I know of a square stack 150′ high which cost less than $7 for labor: it contained 250,000 actual brick.

SMALL CHIMNEYS:—When the walls are 9 and 13″ thick they may be estimated in the ordinary way, but it takes 2 or 3 times as long to lay work as on straight walls. For small flues with 4″ walls the following

table will be useful to get the number of brick required to the lf. The national size is figured with 4 courses to 11″. Waste is allowed at 5% where brick fit, and 10 where cutting is necessary. There is more waste in proportion on a small chimney than on a long wall.—

Size of flue	No. of brick	Size of flue	No. of brick
8x8	28	12x12	37
8x12	34	12x16	43
8x16	37	16x16	46

In most cities a flue-lining must now be used. Chimneys are sometimes taken by the lf according to size. With 1 flue, 8x8 and 4″ walls with flue-lining they are worth,—profit included,—90c; with 2 flues, $1.20. Flue-lining is made in 24″ lengths. For 8x8″ flue, 15c; 8x13, 20c; 17x17, 45c. Labor on small chimneys runs about 30 to 35c on 8″ single flues; and 45 to 50c on double flues.

Chimney-breasts wide enough for mantels may be estimated by the ordinary rules. They are occasionally taken at $5 per ft of hight, but this depends upon size, and is for common brick. With ornamental pressed brick, twice that figure is sometimes too low.

Measure brick arches for sidewalks, fire-proofing, etc in the ordinary way and allow the centering extra. In both walks and fire-proofing it is usually possible to hang centers to the steel beams. Brick are very seldom used for fire-proofing now, and the centering for terra-cotta is of plank which does not require any labor except the preliminary bolting of hangers which are changed from span to span. For sidewalk centering allow 5c per sq ft. Usually only a couple of centers are required, as they are moved.

For nearly 2 months of my apprenticeship I worked on a large Gothic church making, setting and removing centers, but unfortunately I kept no time as the most interesting time then was the time to quit. I have never kept time on centers since. Like tool-houses, temporary fences, engineer to set stakes, etc, they are a necessary evil which runs away with honest money.

Here is something most contractors have read before: "1,000 brick closely stacked occupy about 56 cf; 1,000 old brick cleaned and closely stacked occupatou by 72 cf." In the first case the actual room required for the solid mass would be about 45 cf at national size, and the 11 cf are needed for voids.

Many thousands of old brick were lately cleaned for $2 per 1,000, which is a high price. Cleaning is sometimes done by piece-work for $1.

PRESSED BRICK:—Get the exact No. of sq ft and mult by 6½ to 7 for the No. of brick. More brick are required than for common work because the joints are smaller, and 4 courses make only 10″ instead of 11 or even 12 with good sized common brick. Reveals if more than 4″ deep have to be figured. The size of pressed brick varies, as well as the size of the joint, but 6 of the average brick with neat joint will cover a space 10x13 inches. With some brick and a large joint 6 are sufficient to the sq ft. It is possible to make the joints too small.

Sometimes brick are laid in a bond that shows many headers, and thus a brick covers but half the surface it does when used as a stretcher.

This means an extra allowance of material if architect does not permit headers to be cut. Molded brick running around doors, windows, arches, projections, etc take up much of an estimator's time when preparing a bid. They are often of a dozen different kinds with as many different prices. With brick at 3c to 15 one can not afford to be careless. Deduct the number from the plain brick if the whole surface has been included. Do not order too many as they will not be taken back; do not estimate too few as each brick may cost 20c.

There ought not to be much waste if brick are good, but there are architects who expect a $30 front for $14, and sometimes steal from a contractor by rejecting brick which are up to the specification. To get at the number of Roman or any other special brick find the number of sq in. in sample, allowing $\frac{1}{8}''$ on 1 side and 1 end for mortar. Five courses of the average Roman make 9″ in hight; their length is $11\frac{1}{2}$ to $11\frac{3}{4}$, so that 7 are required to the sq ft.

Enameled brick may be estimated in the same way as pressed brick. They run from $90 to $100 per 1000 kiln count in the wall.

There are so many kinds of pressed brick that the descriptive catalog and price-list is $\frac{1}{4}$ as large as this book. Why attempt to give prices here? A fair brick may be had for $15, a better one for $25, and a beauty for $40 per 1000. All colors are now at our service, and color cuts some figure in the price. The standard is red, and the prices on the various colors run from 30 to 50% more. The packing on a small order costs $7 per 1,000. Molded brick are sold only with straight brick unless in exceptional cases. A car-load is 8,000.

"Owing to different shrinkage of the various clays required to produce different colors, exact sizes can not be given. The following are approximate:"

Standard size—$8\frac{3}{8}$x$2\frac{3}{8}$x$4\frac{1}{8}$ Roman size—$11\frac{3}{4}$x$1\frac{1}{16}$x4

Impervious white or grey face:

Standard—$8\frac{1}{8}$x$2\frac{1}{4}$x4 Roman—$11\frac{1}{2}$x$1\frac{5}{8}$x4

Enameled sizes are about the same. Roman tile is enameled size set on edge. English enameled is 9x3. Care must be taken when estimating headers as end only is enameled. Enamels may be had in white, buff, brown, blue, and green.

It is necessary to watch arches. If brick have to be ground to fit the radius they cost from 5c to 25c each. Sometimes they can be laid without grinding, and there are contractors who prefer to chip them, which seems to show that the manufacturers charge too high a price for grinding. To chip and lay a jack-arch 17″ high, 13″ reveal, allow $10. There are 300 different kinds of molded brick, and about as many different prices.

Salt-glazed, terra-cotta wall-coping is made in 24 and 18″ lengths, and for 9, 13, and 17″ walls. Angles, starters and tee branches are made: Straight, 10, 16 and 25c per ft; angles, 50c, 75c and $1.

TERRA-COTTA is of special design and has to be priced accordingly.

BRICK PAVING:—See Chap 6.

MORTAR:—Before we plunge into a discussion of quantities we may profitably look back at No. 2. In that building there were 750,000 brick,

kiln count, and it took 720 bbls of lime and cement to lay them. This is close to a bbl per 1,000. But at least 200,000 were laid in cement at 1¼ bbl to the 1,000. This leaves 470 bbls of lime tempered with cement to 650,000 brick, or practically .85 of a bbl to the 1000. This is 17-20, and with good lime it is sufficient. But some kinds of lime require more. It is impossible to get mathematical figures on all work. Lime may be spoiled, and more required, or it may be of an inferior quality. There was something said about this in the introductory part. One contractor wanted a bbl, another ½ bbl, or at most ⅝, and the largest allowance was 1½ bbls. "From time immemorial 1 bbl of lime and ⅝ yd of sand to 1,000 brick." It is a safe allowance. Something depends upon the thickness of joints, richness of mortar, and so forth. A good proportion is 1 of lime to 3 of sand. Some bricklayers make a bbl of good lime lay 1,600 brick, but this draws a little heavy on the sand pile. A fair average is ⅞ bbl. Ordinary mortar is worth about $1.75 kiln count; with pressed brick, $1.90.

Lime goes much further than cement. In the basement of an Omaha warehouse built in 1902, 1,000 brick wall measure took 1.25 bbls of cement. As there are only about 750 actual brick this means 1.66 bbls to the 1,000. It does not pay to make mortar too short as it is harder to handle than if made in the proper proportion, and what is gained in cement is lost in labor, which at 62½c an hour soon counts.

On another Omaha basement built in 1902 and containing about 250,000 brick, kiln count, 400 bbls of cement were used, or 1.6 to the 1,000.

A publication at hand advertising an excellent brand of Am. Portland cement says that 1 bbl should be sufficient to make enough mortar to lay 2,000 brick with ¼″ joints. That is only ½ bbl to the 1,000 actual count. Joints of this size do not require as much mortar as ordinary ones, but they can not be made with common brick in cement, and if they could the extra cost of labor would run away with the saving in cement 10 times over. Besides, the allowance is far too small. Why not tell the truth, even in an advertisement?

For ordinary masonry I read in an excellent publication that 1,000 brick require 1½ bbls of cement and the same quantity of lime at a proportion of 1 to 3. In another work I find that a bbl of lime will lay 1,000 brick, and that is near enough the mark for good lime, although No. 2 took less. In still another book ¾ of a bbl is the allowance. One authority says ½ bbl of cement, another 1½ bbls, or 3 times as much, and the actual quantity on the basement of 3 large buildings takes 1¼ to 1½ bbls to the 1,000, kiln count; and 17-20 of lime. There is the choice between actual work and theory.

For pressed brick ½ bbl is sufficient, so that a building with pressed brick fronts and thin walls lowers the average.

"With joints ½ to ⅝ and brick 2¼, allow for ready mixed mortar .8 cy per 1,000; ¼ to ⅜ joints, .45 cy."

SAND:—This material is so cheap that an accurate account is seldom kept of how much goes to concrete, how much to brick, plaster, filling and so forth. In general, ½ to ⅝ cy of sand is allowed to the 1,000 brick, kiln count. As nearly as I can separate the total amount under the

various headings on No. 2, 640 tons were used for 750,000 brick. At 3,000 lbs to the cy this makes 420 cy,or .56 to the 1,000, kiln count. An allowance of $\frac{5}{8}$ yd is often made; on this building it runs to 11-25 or a trifle less. Again you will find men who use too much sand as it mixes well with lime. Pressed brick does not take half of the foregoing allowance.

Sand for paving, filling, etc can be easily estimated in cy. Water has to be paid for in most cases. The Omaha rate is 7c per 1,000,kiln count, for tempering mortar and wetting brick; tempering mortar only, 2c; making mortar, 7c. In the first case mortar might be delivered from a mixing-yard and require to be tempered only at building—and in hot weather brick might have to be wet. For making mortar and wetting brick the rate is therefore 14c, which is too much. Contractors prefer a meter, which keeps the cost down to 4c. The Chicago rate is 5c per 1,000.

Per cent of mortar in a cy of masonry: ''Coarse brickwork, joints $\frac{1}{2}$ to $\frac{5}{8}$, 35 to 40; ordinary, $\frac{1}{4}$ to $\frac{3}{8}$, 25 to 30; pressed brick, $\frac{1}{8}$, 10 to 15.''

As there are about 4.4 cf in a loose bbl of cement, and 27 cf in a cy of sand, it is easy to get the amount required for any given proportion of mortar. Thus 1 to 3 means 1 bbl of cement and 13 cf of sand. A carload of lime in bulk may run from 130 to 230 bbls.

MORTAR COLOR:—On No. 2 with joints not less than $\frac{3}{8}''$ 22 bbls were used for a surface of about 20,000 sq ft, openings being deducted. As face mortar is required only on the outside course this means 1 bbl to 5,000 brick. With smaller joints a bbl will easily lay 6,000. This rate was recently used on 30,000 pressed brick. On a building recently erected 5,100 lbs of red color was the quantity required for 80,000 brick, laid in the same size of joint as No. 2. This is on basis of 8,000 to bbl. For fine joints the allowance to 5,000 is too large. For red, brown, and buff one maker allows in his catalog 50 lbs to the 1,000 for spread joints; for buttered joints, 45 lbs. For black, 40 to 45 lbs; and 25 to 35 buttered. A bbl of red contains 500 lbs; brown, 450; buff, 425; black, 300 to 500. Red is about $1\frac{1}{2}$c per lb; brown and buff, 2c; black, 3c.

The weights are those of only one manufacturer. His allowances are too close; but a good deal depends upon the shade. Half the proper quantity may be made to serve. Some contractors find that 1 bbl is sufficient for 8,000 brick. A good deal depends upon the mixer. A raw hand wastes material without improving the mortar.

LABOR:—The cost of laying the brick in No. 2 was too much, but a common brick front was made to look as if it were of pressed brick. The thanks of the state are principally due to the contractor that this was so.

In wall measure, openings deducted, and only actual contents taken, the cost throughout with laborers' wages included, was $4.20 per 1,000; in kiln count, $5.60. Wages were 45c and 17 to 18c per hour. This was at the rate of 1,150 brick for 1 man in a 9-hour day after laborers' wages were deducted. Different buildings give different proportions of time for bricklayers and laborers, as some require much more scaffolding and hoisting than others: on this one, as far as figured, 5,350 hours of bricklayers took 8,280 hours of laborers, or about 2 of the one to 3 of the other.

Sometimes 4 to 5 is the proportion. On a 1-story building with many angles, a recent proportion was 1,450 bricklayers' to 1,650 laborers' hours.

There were special reasons for the high price of No. 2. All arches were of chipped brick, the soffits as well as the face, a good deal of fitting was necessary, and brick had often to be rechipped. Deep flat arches around the basement openings took up a good deal of time; rowlock arches over all other openings kept the men a long while, for it is far easier to lay brick upon a stone or steel lintel than to turn an arch and chip to suit; a large triple-arched, four-faced corridor not shown on the illustration took long enough to build a house; and the dentil cornice and tower ran the average much lower that it would have been on a plain building. Extra time was taken in using 2 colors of mortar throughout.

But I once knew of buildings having altogether about 1,000,000 actual brick where the No. 2 average was not nearly reached. They were plain, with thick walls, without arches, towers, or heavy cornice, and with only 1 color of mortar, and yet on one the average for 8 hours was 650; on another 750; on the best, 825. It ought to have been at least half as much more, for the buildings were low. It is as well to speak of one risk in an estimate—that which comes from lazy bricklayers. There is a happy medium between slave-driving and loafing. At the rate of even 800 brick per day that is only 100 per hour, or close to $1\frac{7}{10}$ per minute with a laborer and a quarter to assist. It seems that a trained bricklayer ought to be able to double this on plain work.

While at this part I asked a contractor who had done a good deal of warehouse work, "How much is it worth to lay 1,000 brick, kiln count, on warehouses at the 55c per hour rate?" "About $3.75." I asked another with large experience and he allowed $4. On 1 building referred to, if put on a 55c basis, the rate was $7.90; on the other, $8.80; on the worst, $10.50.

Although the price of laying pressed brick is given further on it is next to impossible to get the 2 kinds separated. A better way is to lump all brick together and get the average. I know of several large buildings with $\frac{1}{5}$ to $\frac{1}{7}$ of pressed brick; and the average of the first,—flats,—was 1,200; the second, heavy walls practically on ground level, was 1,450, the third, with 4 fronts, 4 stories, of pressed brick, 1,240. This means from $4.75 to $5.75 per 1,000, kiln count, and $2.90 to $3.90 wall m. Without pressed brick $4 would have been sufficient.

It was said in another part of this book that $2.50 per 1000 wall m., was a reasonable amount to allow on plain work in addition to the cost of the brick laid down. This seems small after the 800 rate is thought of; but a good deal of extra cement work on the basement of No. 9 was done at this figure. With the ringmaster in the circus the horses move at a cheerful pace. But $3 to $4 extra is not unreasonable after openings and corners are deducted.

On No. 2 there are 750,000 brick. At $6.50 for brick and $2.50 for laying we have $9,000, there being 1,000,000 kiln count. Brick, $4,775, lime, say, 700 bbls at 90c, $630; sand, 400 yds at 70c, $280; leaving for labor $3,315, or $4.42 per 1,000, kiln count. The work was figured

at a higher rate for arches, cornices, etc, and for laying the basement in natural cement which is worth at least 50c per 1,000 extra.

On flats, stores, dwellings, halls, etc, the price must be set to suit the class of work with an average basis of 750. There are the extremes of \$3.75 and \$10.50 on common brick. Before establishing your price in all cases consult the bricklayers. The average on No. 7 was not more than 1000. On some days 600 was nearer the mark.

But if we have looked at them while they were playing do not let us forget that they can also work. On the heavy footings and basement walls of a warehouse built in Omaha in 1902, each bricklayer laid 3,200 brick in an 8-hour day; and on another basement this figure was exceeded. No one expects this rate clear to the roof, for above the heavy footings it means poor workmanship, but play at 55c (or 62½c as now) per hour is unbecoming.

In heavy warehouse work with common brick fronts 1,800 ought to be laid; and, if not too far from ground, 2,000 need not be considered miraculous. With 9″ walls 1,000 is enough. About 1,200 for ordinary plain work is a fair allowance. The higher the building the more expensive do scaffolding, hoisting and tending become.

In engineering work with heavy piers and walls, 1,800 ought to be laid in cement and shoved. Work properly shoved is worth not only 50c per 1,000 extra, but a good deal more to the owner. A brick is laid down in a full bed of mortar a few inches from the last one in place and shoved close. The joint is necessarily full nearly to the top and the small space is filled with the next bed if not before. Although specified the work is sometimes not done.

A passenger-station with 76,500 extra large brick was recently laid at the rate of 56 per hour per man throughout. This included a fairly good pressed front of the same brick selected. With short, thin walls, angles, corners, arches, etc, this was a fair rate, which might have been better. But there is a difference between a building of this kind and a warehouse.

Bricklaying machines are on the market, but the perfect one is not yet so far west as Nebraska, and there are no figures at hand.

In Scotland brick contain about 50% more cu in than here. In making comparisons as to number laid per day this is sometimes forgotten. But few brick are used there. In the north of England brick buildings are the rule.

PRESSED BRICK FRONTS:—A common way to estimate this work for a fair quality of material is to get the price of the common brick in the regular way without making any deduction for the outside course, and then to add the cost of the pressed brick laid down at the building. It may be said that to lay brick worth \$15 does not require more work than at \$25, and that therefore the rule is not fair; but in general the higher the price of the pressed brick the finer the quality of the work has to be to suit the architect, who puts on ornament enough to correspond with the value of the material. Fine residences with ornamental pressed brick fronts should be allowed at the full thickness of common brick, then the price of the pressed brick added, and finally \$20 per 1000

extra on the pressed brick for labor. It is well for those who estimate on ornamental work to understand that it is worth this price, which seems excessive, but which has been proved by results to be reasonable —and sometimes risky.

With jambs, corners, molded arches, buttresses with bases and caps to dream about, with chimney-caps when they are reached after a long delay and trouble without end there is no money in this kind of work unless it is done on a percentage, which is about the only proper way to do it,—and then the chief sufferer is the owner who deserves to be punished for his folly. Houses of that kind remind us of a woman with 14 rings on her fingers. A few look well, but we draw the line at 8. Between the extremes of $12 for "culls" and $50 extra for the brick on a house where a dreary architect constructs decoration instead of decorating construction you have your choice. Between lazy bricklayers and artistic architects the lot of a contractor is not a happy one.

Fire-brick and enameled brick are estimated in the same way. Enameled brick take a little more time than pressed brick. When a wall has fine face-brick on both sides allow 10% extra after the other allowances are made. On one of the heaviest buildings in Omaha—the Burlington station—the contractor paid a proportionate price for work of this kind. Do not look for mercy after a contract is signed. "Business is business."

A bricklayer ought to lay from 400 to 500 common pressed brick in an 8-hour day—but if he sometimes lays only 650 ordinary brick in a long, thick wall why expect too much when he goes to the front? The best system is to include pressed brick with common and take the average. Some figures on large work have already been given. I know of 2 passenger-stations where each man in 10 hours laid 250 to 270 pressed brick as an average, and also backed up with a 9″ wall. With short runs jambs, and arches, this was a fair day's work, for it averaged about 650, brick. With long, straight, thick walls the number would have been increased 50%.

It is worth from $3 to $4 extra to lay brick in Flemish bond.

VENEERING:—Allow 400 for 1 man in a day. The 1st story of No. 10 is veneered; but the fashion seems to be dying out.

To properly wash a building and point the joints is worth 3c per sq ft. Allow 1 gal of muriatic acid to 500 sq ft.

In Lincoln there is a kind of a craze for chipped brick. It looks well on a basement, on arches, bands, etc, but not all over the face of a building. The cost of chipping is $2 for a reasonable quantity. Sometimes the price is $2.50; it was once $3. All reveals, corners, soffits of arches, etc, have to be returned, and it is necessary to have this understanding with the chipper if the work is done by the piece. The basement and other parts of No. 2 are covered with the triumph. It takes about as much time to lay it as it does for a cheap pressed brick.

CHAPTER VI.
MUNICIPAL WORK

A building contractor is sometimes obliged to put in a bid on a class of work that does not properly belong to his department. The following figures will be of some use as a check on his own estimate. They are

mostly prices paid by the city of Omaha at various periods. Of course a mile of paving can be done at a cheaper rate than 100 sq yds. In October, 1901, awards were made as follows:

Sheet asphaltum, 5 yrs guarantee	$1.59 sq yd
Vitrified brick, 1 yr guarantee, (concrete base)	1.97
Disintegrated granite, 3 yrs	1.20
Bedford limestone, curbing	.65 lf
Colorado sandstone, curbing	.70
Berea sandstone, curbing	.61
Asphaltic curbing	.60
Artificial stone curbing	.45
Artificial stone combined curb and gutter	.57

In July, 1902, as the result of a fight, some low bids were received. The specifications were as follows: Asphalt, class B, 5″ concrete, 1½ binder, 1½ asphalt; class E, repaving with 1½″ of binder and 1½ of asphalt on broken stone.

VITRIFIED BRICK:—Class C, repaving on broken stone.

STONE:—Class A, blocks 8 to 12″ long, 3 to 5 wide, 6 to 6½ deep, laid on 6″ of concrete; class C, repaving.

Disintegrated granite, 6″ deep.

The lowest bids were: Asphalt, class B, 5 yrs, $1.59; class E, 5 yrs, $1.47 to $1.55. One company asked 20c per yd extra for a 10 yr guarantee. But in Aug., 1902, new bids were received for No. 1 asphalt, $2.25; No. 2. $1.99; and for vit brick, $1.98, or with cement grouting, $2.08.

BRICK:—Class C, 1 yr, $1.16 to $1.24; vit block—Purrington or Galesburg—class C, 1 yr, $1.24 to $1.50.

STONE:—Class A, 1 yr, $2.20 to $2.35; class C, 1 yr, $1.70.

DISINTEGRATED GRANITE:—$1.43 to $1.46 for 1 yr.

The following table is compiled from an "Abstract of Paving laid during 1902." Labor might be higher or lower in other cities than Omaha. The "District" price is taken, as the "Intersection" is practically the same. The quantities run from 3,000 to 17,000 yds.

Material	Depth	Foundation	Depth	Price per yd	Guarantee yr
Vit paving block	4″	old		$1.36	1
"	4″	sand and concrete	1 and 6	1.86	1
"	4″	old		1.65	1
"	4″	sand and concrete	1 and 6	2.08	5
Sheet asphaltum.	1½	old		1.50	5
"	2	concrete	6	1.60	5
"	1½	concrete	5	1.67	5
"	2	concrete	6	2.05	5
"	1½	binder and concrete	1½ and 6	1.59	5
"	2	concrete	6	1.95	5

Brick paving is becoming more popular every year; and contractors often lay it themselves instead of subletting it, as they are likely to do with asphalt and stone. It is therefore worth while to set down a few figures for use in making out bills of material. The No. of brick varies

according to size. Out of 14 specimens received in an eastern city from different yards, 3 took 59 to sq yd; 2, 55; and the others, 46, 48, 51, 58, 60, 65, 68, 69 and 75. The average is 59; but of course an average is useless with such variation in size.

As there are so many sizes it is necessary to get the number to the sq yd for each size separately. Perhaps the best way is to take a large space, say, 100 brick long and 50 wide and by dividing by the No. of sq yds, obtain the average. The disadvantage of taking an exact sq yd is that even figures may not cover the space. Allow $\frac{1}{4}''$ for sand or other joint filler on 1 side and end before estimating. The joints are likely to be as much larger than $\frac{1}{4}$ as to make up for waste which is small with good material. Paving brick are laid on edge on most streets. For brick of the national size allow on edge, 62; on flat, 36. The Purrington Block—Galesburg brick—used in Omaha for street paving takes 45. The price is about $22 FOB; the size, $3\frac{1}{4}$ to $3\frac{1}{2}$ thick, 8 to $8\frac{3}{8}$ long, and 4″ deep. Good sidewalk brick may be bought for $13, or even $10 in some localities.

On a surface of 742 sq yds laid with Purrington the labor ran to 10c per yd for unloading from cars, and 25c for laying. On street paving the allowance for Purrington is 3,000 per day for 1 man.

Cellars run to about 5c per sq yd for labor on flat. On cinder base 6″, and sand 1″, brick floors are often averaged at 10 to 14c per sq ft.

If brick are grouted with cement add 10c per yd; bids are received for Omaha streets at this figure.

The lowest bids ever received by the city for permanent sidewalks ran to 10.4c for hard brick, but not such material as is used on roadway; and 14.75c for cement per sq ft. This was in April 1902; but by referring to concrete floors, end of Chap 3, it will be seen that cement walks were laid at practically the same figure although cement has risen $1 a bbl. In 1904 walks were 14c for cement, and 10.7c for brick. Minneapolis had a Purrington bid for pressed brick paving at $1 per yd.

On sidewalk work a man and a helper should lay about 3,000 brick; but a good deal depends upon the state of the ground as preparation is often half the battle.

In the boom days Omaha laid 25 miles of cedar-block paving on a plank or concrete base. It served for about 5 yrs and then, like the one-hoss shay, went to wreck all at once and nothing first, just at bubbles do when they burst. Repaving—*not* with cedar-block—has been done on 14 miles, and the other 11 are in a state of noxious desuetude. The original price was $1.75 per yd. Asphalt at that time was about $3. Cedar block on plank and gravel is now worth about $1 per yd. On gravel alone 75c.

Of course prices vary in different sections of the country. A technical journal of New York states that in the spring of 1903 bids were received in that city for $250,000 worth of asphalt paving. They ran from $1.08 to $1.12 per sq yd. In former years the figure was $1.76; under Tammany, $3.80 to $5.86. Possibly the writer was painting Tammany too black. The 1903 prices were said to be the lowest ever received in New York—perhaps in the whole country. A New York average for granite

block, tar and gravel joints, and also for sandstone, cement joints, was \$2.80; 3″ wood block, \$1.75; 4″, \$2.20. Granite blk sometimes runs to \$3.25.

In "The Engineering News" of June 18, 1903 some interesting figures are given for 38,504 yds of brick paving in Champaign, Ill. Concrete base was 6″ in the proportion of 1, 3, 3 with 1¼″ of sand on top and then brick paving blocks, 1,000 of which laid 25 yds. The contract price was \$1.29. The actual cost for 1 sq yd was: grading, .10; concrete base, .3985; brick, .7587, a total of \$1.2572, or about \$1.26. The labor on base was 5.8c; on brick 8.87c. Concrete curbing and gutter contract was 46c; actual cost of labor and material, 39c; labor, 26.17c.

The following figures have been tested on large platforms by the Northwestern Railroad Company:

The size of brick varies from 2¼″ to 2⅞″ thick; 4″ to 4¼″ wide and 8″ to 8⅜″ long. No. to yd, 38½ to 39 on flat; 55½ and 60 to 73 on edge.

Cost is from \$7.50 to \$10.00 per 1,000 without freight.

The cost of laying on flat was less than 8c per yd; on edge from 11c to 15c. But this is merely the laying, no filling being allowed, as the depth varies. From 20c to 30c per c yd ought to do the filling. Approx for grading and filling 20c per sq yd.

BRICK SEWERS:—The material can be easily estd if they are circular. Mult the average diam by 3.1416 or 3 1-7, and treat the result as a straight brick wall of 9, 13, 17″, or whatever thickness it may be. To get the number of brick the inside diam of each ring should be taken, for the brick joint is of the average size there, while on the outer margin of the 4½″ ring it has to be increased owing to the radial line.

Suppose a sewer 300′ long, 3′ inside diam, with 3 rings or 13″ thick. The average diam is 3′ 9″, for this is the inside diameter of the middle ring. Mult by 3.1416 we have a wall fully 11′ 9″ high, which contains in wall m, 79,515 brick. By the separate-ring process the 3′ diam at 4½″ thick equals 7½ brick or 21,206; the inside diam of next ring is 3′-9″ or 26,507; inside diam of outside ring is 4′-6″ or 31,807; a total of 79,520 in wall m. See Chap 5 for actual number required. Better brick are used for sewer than for ordinary building work. They are usually \$1 per 1,000 more. For about ⅓ of the hight on the inside ring where the water flows the brick should be extra hard. More cement is needed for sewers than for a straight wall. The joints are wider on the outer diam, and the inside has to be plastered.

Whatever section is used, circular or elliptical, it is only necessary to get the distance around the inside and then proceed as for a common brick wall. Bricklayers' wages are \$1 per hour for work of this kind. They often have to work in water. A man will lay on an average 2,500 brick in a day.

An Omaha price for city sewers, 2 ring, 15′ deep was: 36″, per lf, \$3.55; 42, \$4.35; 54, \$4.60; 66, \$5.60. The manholes are extra at same price as those for pipe sewers.

The 1904 bids from 6 contractors ran as follows—and as with all bids for city work profit is included:

2-ring, 4′ 8″ diam, 900′, natural cement, from \$4.80 to \$6.20 per lf, average, \$5.39; Portland, from \$5.20 to \$6.65, average \$5.83.

2-ring, 5′ 10″, 620′, nat, \$5.95 to \$7, average, \$6.56; Port, \$6.30 to \$8.40, average, \$7.23.

2-ring, 6′, 480′, nat, \$6.05 to \$7.25, average, \$6.59; Port, \$6.60 to \$8.40, aver, \$7.29.

2-ring, 6′ 2″, 381′, nat, \$6.25 to \$7.43, aver, \$6.82; Port, \$6.95 to \$9, aver, \$7.73.

3-ring, 6′ 4″, 330′, nat, \$8.20 to \$11, aver, \$9.37; Port, \$9 to \$11.50, aver, \$10.11.

3-ring, 6′ 6″, 480′, nat, \$8.50 to \$11.25, aver, \$9.56; Port, \$9.58 to \$12, aver, \$10.42.

Manholes to 10′ high ran in nat from \$1.80 per lf to \$3.50, aver, \$2.89; Port, \$2 to \$3.70, aver, \$3.20.

Excavation for large sewers is worth from 50 to 60c per cy in dry soil. But the most progressive people now do such excav with a machine. "The Scientific American" recently gave some illustrations of one at work in Moorestown, N. J., trenching for a sewer system. With the new machine 5 men can dig a ditch 4′ deep and 60′ long every hour. It is not necessary to cut the trench as wide as with hand labor—it is cut to suit the size of the pipe; and it can be cut 6″ deep to 12′. The earth has not to be handled several times over. One illustration shows the pipe in place ready for backfilling; another shows a man in uniform standing on the bridge like the captain of an Atlantic liner. "Who is to do the dirty work under your system, Mr. Bellamy?" the dilettanti asked. Today with mortar-mixers, concrete-mixers, trench-diggers, and other triumphs, Mr. Bellamy might reply that there is not to be any dirty work.

SEWER PIPE:—The following table gives the "Abstract" prices on sewer-pipe laid. The various contracts ran from 300 to about 4,000 ft. The totals were 1,486′ of 10″ inlet pipe, which is in general a trifle lower in price than the straight work; 8,500′ of 8″; 11,493 of 10″; 5,332, 12; 2,238, 15; 291, 18; 963, 20; 1,071, 21.

Two contracts were let for 15″—70c per ft for 7.55′ deep, and 91c for 7.5. One contract for 18″ was \$1.21 at 7.5′ deep. One contract for 20″, \$1.44 at 13.75′ deep. One for 21″, \$1.52 at 10′ deep. For 24″, \$1.96; 30″, \$3.17.

In 1904 bids for 15″ ran from \$1.04 to \$1.38 in natural; and \$1.12 to \$1.40 in Portland for 1,554 ft; for 18″, 165 ft, nat \$1.78 to \$2.50; Port, \$1.84 to \$2.53; 21″, 825 ft, \$1.98 to \$2.25; and \$2.05 to \$2.30.

8-inch Price in cents	Average depth in feet	10-inch Price in cents	Average depth in feet	12-inch Price in cents	Average depth in feet
51	11.5	60	12	70	12
53	12.5	69	16	99	14.75
89	12.25	60	11.25	65	7
52	11.55	60	10.2	69	12.9
51	9.37	59	8.85	54	8.25
55	13.3	63	13.5	66	10.4
67	12	57	12.4	62	11
47	11	61	12.5		
52	9.7	63	13.2		
46	11				
49	12				

The average is not reliable owing to variations in depth, but it is interesting. On the 8″ the average on 11 contracts was 55.64c for a depth of 11.47′; on 10, 61.33c for 12.21 deep; on 12, 69.3 for 10.9 deep.

In connection with the sewers there were 503 vertical ft of manholes. The lowest price per ft was $3.15; the average, $3.38; the highest, $3.81.

There were also 226 vert ft of flush tank with an average price of $5.43; the highest price was $9; the lowest, $4.35. On one contract for 12.7 ft the price was $9; eliminating this the general average was $5.21.

From 75 to 80c was charged for 463 ft of lead pipe; 43,619 lbs of cast iron ran from 3 to 4c.

Price of sewer-pipe:

3 inch	4c	7 inch	10c	12 inch	20c
4 "	5c	8 "	11c	15 "	25c
5 "	7c	9 "	13c	24 "	$1.00
6 "	9c	10 "	15c	30 "	2.20

Ells and bends run about 3 to 4 times more than straight pipe.

CURBING:—More than 3 miles of curbing were laid in 8 contracts. Colorado sandstone ran from 65 to 70c; Bedford limestone, 67c; artificial-stone curb, 75c; art stone curb and gutter, 47, 50, 57.

PAVING.—Minneapolis has recently laid a good deal of creosoted block paving. The price on a 6″ concrete base is from $2.50 to $2.60. This paving has been much used in some European cities. It is made of tamarack, Norway or Southern pine, and is far superior to the cedar block paving. (Sept. 1905.)

BIDS RECEIVED AT NEW YORK, N. Y., NOV. 24, 1903, FOR EXTENDING RIVERSIDE DRIVE.

(A number of items, not of general interest, are omitted. Profit is, of course, included. There is a healthy difference in the bids of more than half a million dollars!)

QUANTITIES.						
Earth excavation for walls, etc.	96,000	cu yds	$0.70	$0.60	$0.50	$1.00
Loose rock excavation, walls, etc.	4,000	" "	1.00	1.60	1.70	1.00
Rock excavation for walls, etc	3,500	" "	2.25	3.00	1.50	3.00
Filling behind walls, etc.	285,000	" "	.15	.05	.01	.20
Filling for park slopes.	60,000	" "	.20	.05	.05	.25
Concrete in walls and foundations.	35,000	" "	6.50	6.40	6.00	6.50
Concrete in arches.	1,900	" "	8.00	10.00	8.50	10.00
Concrete with expanded-metal.	1,450	" "	9.00	18.00	8.50	15.00
Rubble backing for walls.	32,500	" "	5.00	4.00	4.00	4.25
Concrete backing for walls.	11,500	" "	6.00	6.00	6.00	6.00
Concrete in steps, platforms, basins, etc.	200	" "	15.00	7.50	6.00	10.00
Rock-face coursed granite ashlar for walls	6,500	" "	27.00	24.00	29.00	25.00
Rock-face broken-range granite ashlar.	9,800	" "	27.00	23.50	29.00	1.00
Rough-pointed coursed granite ashlar.	700	" "	42.00	32.00	36.00	30.00
8-axed hammer-dress'd granite coping, etc	27,200	cu ft	4.00	3.25	4.00	2.00
6-axed; copings, pilaster, quoins, etc.	45,000	" "	2.50	2.30	3.00	1.75
6-axed; for bridge-piers, etc.	2,000	" "	2.50	2.15	1.75	2.00
6-axed for pedestal stones	2,500	" "	4.50	2.35	4.50	2.00
Rock-face granite voussoirs.	1,500	" "	1.75	2.30	1.50	2.00
6-axed hammer-dressed granite voussoirs.	2,900	" "	2.50	2.40	2.00	2.50
Rock-face crsd ashlar granite, parapet wall	3,700	" "	1.50	1.50	1.25	2.00
Hammer-dressed granite in parapet walls.	450	" "	5.00	3.75	4.00	5.00
Granite in carved heads, brackets, etc.	250	" "	35.00	15.00	25.00	5.00
Dressed granite for steps, cheek-pieces, etc.	1,500	" "	3.50	3.35	2.85	2.00
Piles, under 40 ft in length.	4,500	each	9.00	6.00	10.00	5.00
Timber for foundations and sheathing, etc	85,000	ft, B.M.	40.00	50.00	35.00	50.00
Timber for sheathing, etc, T & G.	2,500	" "	60.00	60.00	50.00	200.00

Bluestone for park steps and cheek-pcs.	500	cu ft	$2.50	$2.00	$2.00	$1.25
Dry filling behind walls, etc.	11,500	cu yds	.50	.50	1.00	.50
Rubble masonry in walls.	29,500	" "	5.00	4.00	6.00	5.50
Bluestone for curb.	3,600	lin ft	1.25	1.35	1.25	1.25
Granite curb.	10,900	" "	1.50	1.35	1.25	1.25
Iron-chain railing.	1,000	" "	1.50	2.50	3.00	1.00
Gas-pipe railing.	3,500	" "	1.00	2.50	2.00	1.00
Ornamental bronze railing.	120	" "	30.00	30.00	30.00	30.00
Iron railing.	730	" "	10.00	10.00	10.00	10.00
Waterproofing.	8,500	sq yds	.06½	.07	.05	.05
Cast iron.	140,000	lbs	.75	.60	.75	.75
Steel beams.	850,000	"	.04	.03½	.04	.02
Steel girders, posts, bracings, etc.	5,800,000	"	.04½	.04	.04½	.02
Telford macadam roadway.	29,000	sq yds	1.50	1.80	1.50	1.25
Bridle path.	4,200	" "	1.20	1.25	1.25	1.50
Asphalt walks.	500	" "	2.50	2.50	2.00	2.00
Cement walks.	27,500	" "	1.50	1.60	1.50	1.50
Flagging for walks.	1,800	" "	2.75	2.35	2.75	2.50
Gravel for walks.	4,100	" "	.60	.45	.50	.30
Sod.	230,000	" "	.02	.03	.02	.02
Mold.	11,200	cu yds	1.50	2.00	1.50	2.00
Brick sewer, Class 1.	2,250	lin ft	10.00	6.00	4.00	4.00
" " " 2.	870	" "	12.50	8.00	5.46	6.00
" " " 4.	20	" "	16.50	10.00	4.43	5.00
" " " 5.	20	" "	25.00	12.00	6.60	10.00
" " " 6.	80	" "	40.00	25.00	18.00	15.00
" " " 7.	140	" "	20.00	12.00	13.50	8.00
Circular brick sewer, Class 8.	350	" "	12.50	8.00	4.00	6.00
" " " " 9.	10	" "	18.00	9.00	6.00	8.00
Circular cast-iron pipe sewer.	100	" "	35.00	20.00	16.00	12.00
Circular brick outfall sewer, Class 11.	40	" "	48.00	20.00	13.38	15.00

Circular wooden outfall sewer, Class 12	10	" "	30.00	10.00	6.00	8.00
Salt-glazed vit. stoneware pipe, Class 13	1,550	" "	3.50	2.50	3.00	1.75
" " " " " 14	250	" "	5.50	3.00	2.69	2.40
" " " " " 15	550	" "	2.00	2.00	2.48	1.50
" " " " 16	900	" "	1.75	1.80	1.92	1.50
" " " " " 17	750	" "	1.25	1.00	1.30	1.50
" " " " " 18	1,200	" "	1.20	.80	1.16	1.00
" " " " " 20	200	" "	.75	.05	1.05	1.00
Manholes, Class A and B	34	each	70.00	60.00	100.00	75.00
Dry rubble masonry	2,500	cu yds	2.00	1.50	2.50	2.00
Water-pipe	200	tons	35.00	30.00	26.50	35.00
Special pipe	10	"	65.00	65.00	58.00	70.00
12-in water-pipe	4,700	lin ft	.30	.40	.50	.50
6-in water-pipe	800	" "	.25	.30	.50	.50
Brick masonry	40	cu yds	15.00	12.00	15.00	15.00
Multiple 4-duct conduit	6,600	lin ft	.75	1.00	.75	.50
Multiple 3-duct conduit	750	" "	.70	.75	.70	.50
Single-duct conduit	2,300	" "	.65	.40	.35	.25
Brick manholes	16	each	110.00	70.00	100.00	100.00
Brick service-boxes	57	"	50.00	40.00	50.00	60.00
No. 4 cable	30,200	lin ft	.25	.32	.28	.25
No. 4 "	5,500	" "	.22	.34	.30	.25
No. 2 "	7,300	" "	.25	.28	.35	.25
Total			$2,202,523	$1,965,016	$2,137,719	$1,651,778

CHAPTER VII.

FIRE-PROOFING.

We shall have to leave the experts to quarrel over what is and what is not fire-proofing. We have tile men who declare that a wall or floor of ex-metal and concrete is a delusion and a snare; and they furnish photographs of building wrecks to support their theory; and on the side of systems other than terra-cotta, porous-tile, etc, there are those who tell us that the days of the hollow-tile arch are gone and point to many fine modern buildings put up with expanded-metal construction.

One thing is certain: we ought to build more fire-proof buildings. While No. 2, which is fire-proofed, was under construction a large portion of the state penitentiary was destroyed by fire; and shortly after that a state building at Norfolk went up in flames and came down in ashes. Both were of wood construction; and the loss on these 2 alone would have nearly fire-proofed all the non-fire-proof buildings belonging to the state of Nebraska.

In the early summer of 1902 at Co. Bluffs a large school for the deaf and dumb was burnt to the ground. About the same time another expensive Iowa building was destroyed. In Jan., 1904, $300,000 damage was done to the state capitol.

These are the only few instances taken from our own neighborhood, in a short period, but they show the folly and danger of erecting certain classes of buildings in the old style. The Iroquois theatre horror may easily be duplicated any day.

One of the most reckless ways of investing money now is to put it into an office-building of wood construction; one of the most risky things from the business point of view is to fill such a building with valuable records.

Without going into detail it may be said that approximately fire-proofing reduced to the lowest basis costs from 20 to 25% more than the regular construction. It is worth 50% more in safety, durability, and lower insurance rates. The cost of ex-metal fire-proofing as compared with wood construction is given by the official publication of the companies as from 8 to 20% more.

The annual property losses in the U. S. run to $150,000,000, or enough to build a far better city than Omaha. Albany, N. Y., with less than 100,000 population burns more than Berlin with 1,800,000—but Berlin does her own fire insurance and has strict building laws. Baltimore burned up $100,000,000 in a day and night.

No. 2, which is only a $40,000 shell, cost with tile fire-proofing, about 14c per cf. Buildings for U. S. government run from 21c up to $1.23:

Omaha, Neb.	71c per cf	Fort Scott, Kans.	31c
So. Omaha.	25c	St. Louis, Mo.	97c
Lincoln.	43c	Kansas City, Mo.	57c
Beatrice.	31c	Chicago, Ill.	49c
Nebr. City	21c	Denver, Colo.	50c
Co. Bluffs, Iowa.	45c	St. Paul, Minn	65c

Sioux City, Iowa....	17c	New York................	$1.03
Wichita, Kans......	23c	Boston....................	1.23

HOLLOW TILE
PRICE

8, 9, 10″ floor- or roof-arches set....................	22c per sq ft.
12, 14″....................................	24 to 28c
16, 18″....................................	25 to 35c
4″ partitions..................................	12c per sq ft
6″..	15c "
8″..	18c "
3″ roof-tile, 12c; 3″ book-tile, 12x17................	7c "
2″ furring-tile................................	7c "
½″ ceiling-tile................................	6c "
Girder-covering..............................	15 to 25c per lf
Column-covering..............................	30 to $1.00 per lf

These prices are for work set in place. Of course they are for straight work. Floor-tile might run to 50c instead of 28; and wages instead of being 45 to 55c per hour might be 60 to 65 for bricklayers who have, as a rule, to be broken in to the work. Roof-tile is usually thinner than floor-tile and easier laid, but the hoisting costs more, so that for an ordinary job it is not worth while to make any deduction.

The raw material FOB Omaha runs about as follows:

8, 9, 10″ arch-tile..............................	15c per sq ft
16 to 18″....................................	17c "
4″ partition, 8c; 6, 11, 8.........................	14c "
3″ roof-tile...................................	9c "
2″ furring-tile................................	4c "
Ceiling-tile..................................	5c "
Girder-covering..............................	10 to 20c per lf
Column-covering..............................	25 to 50c "

But of course better prices are given on a lump job, especially if the mackolite, monolith, concrete men are in attendance. Competition is the death of prices. When near the factory a cut can be made. The freight on No. 2 for example, was $1,500, or about ¼ of the total cost.

It is in general safer for a contractor to get a bid from the tile company for the work set in place—not delivered on the cars. There is sometimes a good deal of breakage. If bid is taken for material it is better to have it understood that enough is to be furnished to complete the job, and not a certain number of sq ft. The manufacturer does not like this as it throws the breakage on him, but while a contractor is careful and conscientious he does not like to run against a shortage. A sufficient guarantee for the manufacturer is that the contractor, if he hauls and sets the tile, does not care to pay for handling it any oftener than possible, and thus guards against breakage.

Steel is not estimated in any of the systems. Sometimes a company puts in a bid on the basis of its own steel plans, using lighter construction than the architect. In putting in a bid on a complete building with a certified check it is necessary to mention any departure from

the weights, or else the contractor may be held to the cheap fire-proofing coupled with the heavy beams.

MEASUREMENT:—Except for beams, columns, etc, which are taken by the lf, all work is measured by the sq ft. Floor- and roof-tile are of various shapes to suit the part of the arch to which they belong.

QUANTITY:—Waste ought to be within 3%, but sometimes tile are smashed in cars. Lime, which has to be much richer than for ordinary brickwork, may be estimated on basis of 175 bbls for the fire-proofing on No. 2, as noted under "Labor." The necessary lumber for hanging centering below I beams cost $140. Half a yd of sand to a bbl of lime is more than ought to be used.

LABOR:—On No. 2 16,500 sq ft of 12″ floor-tile; 5,500 of 10″ roof-tile; 5,500 of ceiling-tile; 4,200 of 4″ partition; 15 columns; 351 lf of I beams took for labor and hoisting $1,700, with bricklayers' wages at 45c. But the subcontractor who did the work had unfavorable conditions to contend with. Hauling is not included. A haul of a mile costs about 50c per ton.

A fair price for labor on the tile fire-proofing per sq ft is about as follows: Floor- and roof-arches, 4½ to 5c; ceilings, 1 to 1¼c; partitions, 3½ to 4c; beams and columns, 4c. If everything goes well this will cover the cost at 45c per hour. These prices would have run No. 2 to about $1,400.

No. 3 is fire-proofed throughout on wood for ceilings, but with tile partitions and wall-linings. The prices are practically the same as for No. 2. Bricklayers' wages in Omaha are now 62½c, and an extra allowance has to be made from the 45c basis.

EXPANDED-METAL FIRE-PROOFING:—The associated companies do not, as a rule, sell to contractors whom they accuse of mistaking sand for cement. They do their own work and take no risks. They are justified in this course, for their tile brethren have published some photographs that do not look well for the new system. One failure discounts a score of successes. Now they handle their own material and take the responsibility.

I bought about 200 yds for No. 2 and had no trouble in making a strong floor. Nos. 7 and 14 have large lavatories on the same kind of base.

PRICE:—Their prices vary according to load and span. A span of 8 ft with 3″ of concrete from 17 to 20c per sq ft, depending upon locality and cost of material. From 8 to 20′ spans, 25 to 28c. "These prices are for wood floors, 5c per sq ft to be added for finished concrete floors, taking the place of wood." There is also an addition of 5c per sq ft for heavy warehouse floors, up to 600 and 800 lbs per sq ft; or for top-dressing and warehouse floors 90c a sq yd, which added to the base touches $3 per sq yd.

My 200 yds ran somewhere in the neighborhood of $1.50 at 3″ thick, and it was strong enough to carry loaded wagons. But there was no profit at this figure, and wages were lower than in large cities. If well built the system is an undoubted success.

For walls of ex metal and concrete 2″ thick, not too far from ground, allow $1.60 to $2 per sq yd.

MEASUREMENT:—Unless of a special nature all work is measured by the sq ft.

The developments in ex metal and concrete are astonishing. Sewers, culverts, tanks, bridges, and a hundred other structures are now built of the combined materials; and if we include ex-metal lath there is no end to the decorative possibilities of our latest triumph. The work already done speaks for itself. There is room for both tile and concrete men. In the U. S. alone between 500 and 600 buildings, costing from $5,000,000 down have already been fire-proofed with ex metal and concrete; up till 1902 10,000,000 sq yds of floor metal had been used, and 30,000,000 yds of lath. In 1902 in the Chicago territory alone, 3,000,000 sq ft of floor were laid, or enough to cover about 69 acres.

QUANTITY:—The metal costs from 6 to 7c per sq ft. The concrete may be estimated from the quantities given in Chap 3. Temporary boards or planks have to be used under the complete space to be covered. They should be smooth on the finished side So closely does the cement take on the face of the board that one sees a clearly photographed inverted reproduction of the most delicate grain of the wood.

Panels are made as large as 20x20′ without a support—and a New Orleans' drainage canal is 13′ wide in the clear by hundreds of ft long. A span of 4 to 8 ft is usual. The material comes 8 ft long, and in 3′, 3′ 6″, 4′ and 5′ widths. Ends of metal should be lapped 2″ but not laced or nailed, even if wood joists are used, for the concrete slab ties the whole together.

"We usually use in our concrete work No. 16 gage, 2½″ mesh, and would recommend that for floors of 5′ or 6′ spans, or even up to 8′ spans. For metal lath, we use C 16″. We never fasten the sheets of our floor material, excepting to take some of the straight ends of the sheets and turn them up over the diamonds of the other sheets."

For a wall a plank lining has to be put on both sides the required thickness apart, say 2″, and then the metal being fastened in position the concrete is poured in to the top. More plank is then put on top and shored plumb; and so on to the roof. For a low building the system works well, but it is rather expensive. But lighter foundations can be used than for ordinary masonry.

The plant of the Penn. Steel Co. at Highspire, covering more than 6 acres is built on this system with 2″ walls.

Cinders are often used for stone, as the floor is lighter, and they have had a preliminary burning to prepare them for the test. Cinder concrete averages 95 lbs to cf, while stone runs to 150.

There are several modifications of the ex-metal idea. Rods and laced barbed wire are used in one of the best known.

Partitions are made of ¾ or ⅝x⅜ iron studs set same as wood, and secured to floor and ceiling. Each sheet of lath is tied about 4 times to studs, and a lap is made. For ordinary work the lath goes on only 1 side, and the 1½ or 2″ thickness of plaster covers all iron. Where room

for pipes, etc is required wider studs are used and lath is put on both sides. Studs with barbs to hook on lath are also used.
LABOR:—The metal is easily laid if there are no obstructions, and if the ordinary system is followed. Sometimes beams are to be surrounded. For this work allow 5c per sq yd. Half that amount is enough for the flat system. Allow planking extra at about same price as for arched centering. See Chap 5, page 45. In general $12 per 1,000 is enough for work easily reached. For cement, concrete and cement work, allow about the same as given in Chas 3, if not too far above ground level. For time on lath see Chap 8.
FIRE-PROOF WINDOWS:—At the end of Chap 12 the price of iron shutters is given. They are used with wood frames, sash, and common glass. The newest style of fire-proofing is metal frames, sash, and wire-glass, either ribbed for warehouses or plate for business buildings. In one year in New York City alone 700,000 sq ft were put in place. Iron shutters are not required. The wire-glass is of the usual thickness of $\frac{1}{4}$ or $\frac{3}{8}''$. See Chap 11 for price.

The cost of frame and sash differs according to size, and can not well be given on sq ft basis, for the labor of riveting is the same for the 12 corners on all ordinary sizes. A frame and sash complete with pivots or pulleys costs about $20 for the average size of 2′ 6″x7′.

CHAPTER VIII.
PLASTER

Plaster is often included in the mason work and is therefore considered here, although the joists are not yet in place.
MEASUREMENT:—The ordinary rules do not deduct openings unless they are larger than the standard size; attics are measured square without deduction for slope of roof, and so forth. But by following this method it is as with brickwork,—we can not make out a bill of material from original figures with any degree of certainty, for the openings in 1 building may be only half of what they are in another, and with such variations too much or too little is billed. It is better to change the method and charge the difference in the price. Here then we take only actual surf. But contractors and owners have to be careful in letting work by the yard. In the first cottage I built I paid for my attic lesson.
PRICE:—Two-coat work is now worth 28c; 3-coat, 32c in white finish; with sand finish, 3c extra. This is on basis of wood lath. If plaster goes on straight brick walls deduct 3 to 4c per yd. But in some cases a contractor would prefer to lath crooked walls rather than straighten them with tons of mortar put on at 55c per hour. Keene's cement is worth 7 to 8c extra. The price of the material is nearly 3 times more than the other standards, but less is used, as common lime is merely gaged with cement. These prices are for plain work. Add for metal lath according to local rate—approximately 13 to 16c more.

Back plaster does not seem to be so much used as formerly. It is worth about 17c per yd. The lathers charge double price for lathing in between studs. Heavy rough plastering behind wainscoting, 10 to 12c per yd.
LATH:—From 1,450 to 1,500 wood lath are sufficient for 100 yds.

Some buildings require more than others as angles, brackets, coves, etc take more material; but 1,500 ought to cover the worst. It is necessary to remember now, however, that a new lath is in the market. It is only 32″ long instead of the standard length of 48″. An order for so many lath might bring the number but not enough to cover the surf. About 2,200 are required. Taken on a 48″ basis the price is from $1.25 to $1.50 less per 1,000, so that this kind is gradually working in, although it costs about 1½c more per yd for labor and nails. Wood lath, with labor and nails, runs to about 12c per yd: metal lath etc, 23 to 26c.

Give the actual No. of yds for metal lath. There is little waste as it bends around all corners. There is 1 yd to a sheet, and sometimes a trifle more. Expanded-metal is the common kind; but many plasterers prefer sheet-metal as it takes less mortar. Wire lath is also used, but the ex-metal seems to be gaining the day.

NAILS & STAPLES:—Allow 9 to 10 lbs of 3d fine nails for 100 yds of wood lath at 16″ centers; with 12″, from 12 to 13. Short lath require an extra nail for each joint. A hardware firm sends out a sheet giving 3½ lbs of 3d fine for 1,000 lath; doctors differ. Allow 9 lbs of ¾ staples to 100 yds of metal lath. Somewhat less than this was sufficient on No. 9. The sheets do not require much fastening.

LABOR:—The 48″ wood lath is nailed on in Omaha at 3c per yd, but this includes the openings under the old style of measurement. I read a short time ago that the Chicago lathers had set a day's work for 1 man at 25 bundles, but each man has to nail on the 1,250 lath which they contain. If he comes short of his number it is made up by the others of the gang. With about ⅙ allowed for openings this is 100 yds in a day.

Metal lath was formerly put on for 3½c, but now lathers will not work on it except by the hour at 40c. The cost of 6,800 yds on No. 9 was 4c per yd. On plain work a man ought to put on 100 yds; some can put on 150 to 200, but the average is less. I know of nearly 300 yds which cost 8c. Elliptical work, groins, etc should be allowed at 2 to 3 times the price of plain work. The figures given for lath include scaffolding.

SAND:—Ex-metal lath takes a good deal of material, cement plaster as well as sand. No. 9 took 2.6 to 2.75 yds to the 100, but this included openings. But 1½ to 2 yds are usually enough for a building with wood lath or brick walls without lath. If wood lath are used all through 1¾ yds are enough. On No. 2 with all work on brick or fire-proofing 2 yds were required. But it is different with crooked brick walls and ex-metal lath.

A finer sand is sometimes used for sand finish. On some government work a ground rock is specified. On the Omaha post-office the cost of this material was $7.50 per cy. The quantity used for the last coat was about 1 yd to 150. Ordinarily a clean common sand is run through a No. 18 sieve.

CEMENT PLASTER:—On No. 2 with 6,600 yds actual surf the quantities were as follows: 600 sacks of hard plaster; 191 of stucco; and 110 bbls of lime. The walls were straight and did not require as much as is sometimes used. The work was 2-coat white finish.

The quantity of stucco is unusually large, but there were 2,500 lf of

$\frac{7}{8}$x10″ base, and 500 of 6″ chair-rail plastered on the face of the wall, besides small cornices, capitals, bases, etc.

For plain work about 65 bbls of lime and 85 sacks of stucco are required for white finish on 6,600 yds. Some kinds of cement plaster can be used for a finish coat, but not the kind specified for No. 2. But by allowing 1 bbl of lime to 4 sacks of plaster we can get at the total quantity which would have been necessary if cement only had been used. We have then, 600 sacks of cement plaster, 90 of stucco, and 65 bbls of lime, or equal to 260 sacks of plaster, a total of 950 sacks for 6,600 actual yds, or 7,000 with openings. This is 14.4 sacks for the first, and 13.6 for the second measurement to the 100 yds. For cement plaster alone 9 sacks were used on the 6,600 basis, and 8.6 on the 7,000. The diff is thus seen if cement is to be used for all work, or if required for first coat only.

On about 525 actual yds, or 600 with openings included, the quantities were 15.4 and 13.3; and there was no lime used for finishing coat. This was on the building whose roof is shown in No. 11.

Care must be taken to see just what surf is to be plastered. Some architects specify that all walls behind wainscoating shall be covered with a heavy coat of rough plaster. On certain buildings this might mean $\frac{1}{5}$ of the surface. Both for price and quantities it is necessary to know; and it is best to be sure before contract is signed.

The 2 buildings given are on basis of brick or wood lath; wire or metal lath requires more. I know 1 building that took close to 20 sacks, but it was all metal lath, and nothing was used except cement for all coats. At least 16 ought to be allowed on work of this kind, and that is often too close a figure, especially if plasterers are unacquainted with the material. Nowhere do good tradesmen work so clearly for their wages as plasterers on metal lath. A new hand puts half the material on the floor; with him it will not stick to the wall and still less to the ceiling.

On No. 9 with more than 8,000 yds of 3-coat work on metal lath 18 sacks was the average, but openings are included. Cement only was used.

These actual results from large buildings show the danger of estimating work from manufacturers' catalogs. I find from one that 8 sacks of white and 10 of dark cement are sufficient for 100 yds of 2-coat work. With lime and stucco for a finish coat, this is about the same rate as was used on No. 2; but No. 11 without lime tells another story. Only the thinnest kind of work can be done with that quantity, and the walls have to be straight. It is not nearly enough for metal lath which, unlike other surfaces, requires a thin first coat before the heavy brown coat will stick. This accounts to some extent for the increase in the quantity. White plaster does not require so many sacks as it takes more sand than dark.

Keene's cement, as already stated, is a lime plaster gaged with cement, and requires only 6 sacks to 2-coat work.

But it is hard to give an exact quantity for different kinds of buildings and work. No rule can be found for crooked walls. Reasonable quantities are based on the theory that walls are to be straight.

Sanded plasters are never used here. We like to sand our own. Some of the unsanded are: Flint, Ivory, Imperial, O. K., Laramie, Baker, Eureka, Mineral City, and Kallolite. The last 2 are from Fort Dodge, Iowa. No. 2 is plastered with Kallolite. The B. & M. headquarters building, Omaha, with O. K. from Okarche, Okla. Baker is white; O. K., Eureka, Peerless, Agatite are dark.

PUTTY:—No. 2 took 1⅔ bbl of lime to 100 yds, but this was owing to the amount required for base, chair-rail, etc. No. 9 took less than a bbl. Three sacks of stucco were used to 100 yds on No. 2 on account of base, etc, while 100 yds required only 2 sacks of cement plaster on No. 9. If lime is used allow 9-10 bbl to 100 yds.

Plaster of Paris is sometimes substituted for stucco as it sets slower. On common work 1 to 1¼ sacks to 100; on good work, 1½. Both p of p and stucco are mixed with the lime which is run off to a pure white.

HAIR:—Hard plasters are supposed to be mixed with enough hair to make the mortar stick; but metal lath sometimes requires a little more than the manufacturers' allowance. At most allow 1 bu to 100 yds, which is the old allowance for lime plaster, although there are those who call for twice as much for lime.

LIME PLASTER:—It is hardly worth while saying anything on the subject. Lime plaster is scarcely ever used now. Lathing, sand, and various finishes are same as for cement. For 2-coat work allow 2½ bbls to 100 yds; for 3-coat, 3.

PRICE:—Cement plaster is about $7 per ton; but sometimes it is as low as $4. It seems to depend upon the manufacturers, and not upon the supply. Keene's cement is about $18. Metal lath, from 19 to 22c per yd; 48″ wood, $4.50 per 1,000; Omaha water rate, 2-coat, 10c per 100 yds; 3, 15c.; the meter rate is cheaper. The Chicago rate is $1.50 per 1,000. There are usually 20 sacks to the ton of cement plaster.

LABOR:—On No. 2 the labor on 2-coat work ran to 15c throughout; but 14c if openings are included. This does not include base, chair-rail, columns, and the rounding of window jambs. Rounding jambs takes from ¾ of an hour on small square windows to 2 hours on high segment openings. If white coat they have to be run with a mold; if sand finish, they can be rounded with a trowel at a cheaper rate.

On the metal lath of No. 9 the cost ran about 4, 7, 4c or 15c in all for the 3 coats. The first coat is thin, the second takes far more material and labor, and the last, or white coat, is about the same as the first. All through the time runs about 9 hours of plasterer to 5 of laborer, but this depends a good deal upon the character of the work. The brown coat takes more laborers than the finish. Sometimes the proportion is man to man.

The labor on 2-coat work is taken as low as 12c, but not in cities where wages are high.

If work is done in winter the question of heating has to be considered. In dwellings it is worth 3c per yd; on large buildings with steam heat, 2c. If in summer, muslin screens may have to be put on all openings. Muslin is worth about 17c a yd.

These rates at 55c per hour can be adjusted to suit the wages of any

locality; but country tradesmen do not always cover as much ground as city ones, especially if metal lath is used.

CORNICES AND ORNAMENTAL WORK:—Almost every house I worked on in my apprenticeship had at least 1 room with a plaster cornice and centerpiece; houses costing about $5,000 had them in every room, and more expensive houses had plaster ornamentation in keeping with other features. It was the fashion, and in architecture as well as clothes that settles everything. The fashion is reversed in the west. Few houses have cornices, and they are better without them, although a small molding looks well. A plasterer might write a book on the subject of cornices alone; for our purpose a few lines will do. Allow for straight cornices of 12″ girt, 25c per lf; 16, 40c; 24, 60c. Allow the price of $1\frac{1}{2}'$ extra for each miter. For cast stuff such as egg and dart molding, 25c. For circular cornices mult by 2; for elliptical, by 3. Bases and capitals of columns can usually be bought cast if there are many of them, or the plasterer can cast them himself. For 12″ cols they are worth about $8 a pair. Pilaster caps and bases are about the same. To finish a 12″ round col with base and cap by hand allow 2 men $1\frac{1}{2}$ days for all work—plain and ornamental.

Material for ornamental work may be calculated by taking the section and dividing in the proper proportion, if so much accuracy is desired.

BLACKBOARDS:—There are several expensive blackboard preparations, but a good cheap blackboard that will last 20 years if well kept can be made as follows: $\frac{1}{3}$ lime, $\frac{1}{3}$ fine white sand from crushed stone gaged with $\frac{1}{3}$ of plaster of Paris and sufficient lampblack to color. Put 1 package to 3 buckets of finished material. Apply the same as white coat. Blackboards of this kind are worth from 10 to 15c per yd extra.

OUTSIDE WORK:—One sometimes sees parts of a house covered with expanded-metal lath plastered with cement which is occasionally pebble-dashed. This work is worth $1 per yd with scaffold already in place. It is usually in panels and the plasterer does not get a chance of covering so much surf as on a plain wall.

If complete half-timbered house is plastered outside with Portland cement on ex-metal lath allow 75c per yd. Both north and south the old style is coming back, with ex-metal for a new and better base.

CHAPTER IX

CARPENTER AND JOINER WORK

Section 1

LABOR

DIMENSION LUMBER:—I have sometimes asked contractors what system they followed when estimating the labor on dimension lumber, and their reply has been in line with my own experience: "Take off every piece of lumber and figure the labor at so much per 1,000′ bm." It is a very simple rule, and I cannot think of any contractors who do not abide by it, except that when in a hurry they may sometimes take work by the square on a safe basis. The difference between this rule and 10 different rules for lumber in as many positions is that the memory can easily carry 1 while it gets 10 mixed and is sure of none.

It takes much longer to cut a rafter to a double bevel on 2 ends than

merely to lay a joist on a wall or nail on a sheeting board; a tower and a dormer window devour time, and a plank floor goes down fast enough to suit even a contractor; but while as a matter of theory each class of work should be figured separately, as a practical affair the whole bill of framing lumber, and usually sheeting also, is averaged with results sufficiently close to serve for 9 buildings out of 10.

Take the lumber by the 1,000′ bm, and not by the lf. I ran across an estimate book which put all dimension lumber from 2x4 to 2x14 on the same basis of so many lf in a day. "It is to laugh." The writer had evidently never hoisted or laid timbers of the various sizes. I have sometimes heard it said that a 2x6 can be handled as easily as a 2x4. Upon that theory a 2x8 can be put in place as cheaply as a 2x6, and a 2x4 is practically equal to a 2x14. It will not work. The progression is made only 2″ at a time, but if you try to hoist or lay a 2x12 you will find it about 3 times as heavy as a 2x4. On a ground floor the difference is not observed so much as on one 40′ in the air; but the whole lumber bill is estimated, and there is only one fair way to do it.

But on the different classes of buildings how shall we determine the number of ft? By observation and experience. If a building has 10 towers and 14 dormer windows it does not require a sage to know that more time is required than if there is only a plain surface to cover.

On some buildings I kept an exact account of time; on most I did not, as the one simply repeated the story of the other. No. 10 was kept. It is a block of 6 flats on 19th and Davenport Sts, Omaha. The first story is frame veneered with brick; all the rest of the building is frame covered with slate. The rear and alley walls are as plain as possible; floors, flat roof and partitions were easily handled; but the time taken on the towers and fronts ran into money. When built 9 hours was a standard day, and the average over the complete building was 550′ bm for 2 men. Now wages are higher by 10c an hour, and the time is reduced to 8 hours, so that the advantage of keeping measure instead of money is seen. Such a building might now be estimated at 550 or 600′ for 8 hours. With fewer hours a man can work harder, and with 40c an hour he has to. As with bricklayers so with carpenters —higher pay has to give more work. But if 600′ were allowed I should want to be on the building myself, and the figure would have to be set subject to the thermometer, which can not safely be ignored. With a plain front 750′ is not an unreasonable figure. An illustration of such a building with the average quantity given is worth a dozen pages of writing.

On No. 4 we have a building of another class. One story has been removed since it was built. The 3x12 joists all through averaged 800′ for 9 hours. They were laid on walls and girders with little framing necessary. The oak posts and yp bolted girders dressed and set in place ran to only 270′. It was then customary to do such work by carpenters, but now since their wages are 40c common laborers are being used, so that 1,000′ of joists alone can safely be estimated on

the carpenter-wage basis for an 8-hour day if the hoisting arrangements are favorable.

One occasionally has to estimate trusses, and it is not always easy to say what they are worth. This is the "10th case" where the average of the framing lumber is not reliable. On this building there were 6 Howe trusses 6′ high with a 60′ span. The timbers were 10x12 for the lower chord in 4 pieces; 8x12 for the top chord solid; 4x12, 3x10 and 2x6 for cross-braces. The chords were bolted together with double rods from 1″ to 2″ in diameter. The story was 18′ in the clear. Each truss contained 2,100 ft bm, and took 342 hours for 1 man to make and set in place. All material came surfaced. No 2 trusses are alike, but this will serve for a guess at another.

On Nos. 4 and 10 the owners did part of the work and managed to fall behind on time and block the way. No. 4 was built in winter, and the government reports were taken as to the quality of the sunshine and so forth, so that the penalty might be levied if the work was not completed on time. It is not pleasant to sign contracts of that kind, but one has to eat. A photograph was at once taken to guard against all danger of pains, penalties, and high displeasure that are so easily laid down in a contract, and there was no more trouble. Sometimes a little care is beneficial in other fields than estimating.

On No. 9 the framing, sheeting, shiplap, and the whole bill of plain lumber, except flooring, cost $8 per 1,000 which was a little too much. It is only 800′ per day of 8 hours. Delays accounted for some of it.

On No. 7 at 40c per hour the sleepers, 6x8 bedded in sand, cost $4.25 per 1,000. The 3x6 floor on top cost $3, but some of it went down for $2.75. The purlins were put in place for $6, and they had to be hoisted about 60 ft; but sometimes purlins cost 40% more. On No. 8 150′x486′, the 2″ flooring on roof cost about $7 for labor, but nailings were about 6′ apart.

On No. 3 the girders were of steel, so that only joists and sheeting have to be considered. On basement and 1st floor there were 22,350 ft of 3x14x22 joists, and 8,300 ft of sheeting. Taking both together 2 men put 1,100 ft in place in 9 hours.

On 2d and 3d floors 44,850 ft of joists and sheeting ran to 1,100 ft also, but this like the material for the higher stories was hoisted by a steam derrick at $2 per 1,000 extra.

On 4th and 5th floors 44,850 ft went down at the rate of only 800, as there was much more framing to do; and as hight makes no difference with a derrick this shows that even on the same building it is necessary to look well over the plans before setting an average figure.

All joists came sized, and there is no bridging allowed.

The sizing of joists is included in all the foregoing buildings except the last. On No. 9 25,000 ft were sized with an average of 3,176 ft in 8 hours; but a good many joists needed to be done on 1 side only. On heavy joists, 2½ to 3½″, well sized, 1,500 is a good average. On a hot day it is too much. In some cities joists are sized at mill on both edges for $1.50 to $2.50 per 1,000.

A good deal can sometimes be said in a paragraph; the largest build-

ings do not need so much space as a cottage. On several of the largest Omaha warehouses recently built the average, without the top, finish floor, runs from 1,000 to 1,100 ft. The joists are merely dropped into stirrups, and they can be placed at 1,100 if taken alone. The heavy planking soon goes down if it has not to be hoisted too far. But posts, girders and joists taken together without plank floor, run from 800 to 900 ft.

From figures already given it may be thought that the heavy platforms around such buildings should go down at 1,400 to 1,500 ft; but I know of more than 100,000 ft which averaged only 700. I know of another with nearly twice that amount of lumber that averaged 1,000 ft. This is after allowing enough for leveling ground. On a plain 2-story building with heavy timbers, 2″ flooring roof, plank under floors, ordinary upper floor, the complete average on 244,000 ft was 770 ft. Upper floors are included and reduce the average somewhat, as they are worth more than dimension lumber. A good deal of the work was done by laborers.

Trestle-work under 10′ high should not run to more than $10 per 1,000 ft. Coal-hoisting stations, towers of a reasonable hight, and heavy timber-work in general should not cost more than $12 at 30c per hour. But there are so many special designs of this kind of work that it is hard to set a figure without seeing the plan,—and sometimes harder when the plan is seen and a guess made at the quality of the man behind the saw.

Sheeting may be averaged at 1,000 ft on a frame building if taken alone, although 1,200 may be done on some. Shiplap about ⅕ less. Much depends upon the style of the walls and roof.

If sheeting and shiplap are nailed diagonally instead of level on side walls allow ⅕ more time.

For floors sheeting may be safely allowed at 1,500 to 1,800 ft unless more than 3 stories above the street level. On the roof of a 6-story building 1,000 ft is a good day's work.

I lately received the time on 1,750 lf of close-board fence 8′ high, strung with barbed wire for a top guard in the usual way. It took 420 hours, but posts were already set. Allow 15 minutes for 1 man to dig hole and set 1 post; but twice as long might be taken. Common 8″ post-holes, 5 to 10 min to dig, and half as long to set.

The foregoing buildings may be taken as typical and estimates securely based upon the figures given. A small cottage will not require as much time in proportion as No. 10; and some large frame houses will not average 550 ft as that did. An allowance must be made for a plainer or more ornate style. The figures can not be far astray at worst if the men work, for 550 is the average of a large building and not a matter of theory.

So with the other buildings. Joists and sheeting cost practically the same on schools, flats, and all kinds of plain brick buildings. If extra framing is required an allowance must be made.

With plain joists, studs and sheeting it is as with brick in a basement wall.—so much is done in a day with reasonable mechanics that one be-

gins to blush over the prospective profits, but by the time the chimneys are capped, the saddles put in place, and the corners attended to it is quite another story. Do not base any estimates on this kind of work, but take an average all through. No. 11, for example, came to only 350 ft for 2 men in 8 hours—but few roofs are so complicated. This included both rafters and shiplap.

As a fair summary allow as follows on an 8-hour basis—but it is well to keep in mind slow saws and modern instances already given:

On average frame houses	600 ft
On wood stores and flats, plain	1,000 ft
On brick stores and flats	800 ft
On 3- or 4-story business buildings	900 to 1,000 ft
On heavy warehouses, mill construction	1,100 ft

BRIDGING:—If taken separately a close enough price may be found in Part 1. If lumber is put in the regular bill allow for labor 150 lf of 2x4 nailed in place, and 200 of 1x3, 1x4, or 2x2 for a day's work. In the first case that is about 300′ bm. Of course joists at 12″ centers require more cutting and nailing than at 20″. It is often cheaper to buy bridging already cut from the mills.

CORNICE:—For a plain cornice of 5 members I have always used 60 ft for a 9-hour day. This does not include lookouts or anything properly belonging to framing lumber. A cottage of 6 to 8 rooms has about 150 lf. This gives 2 men 2.5 days to finish it. At 40c an hour and an 8-hour day that is less than 11c per lf. There is no time for play. Extra members may be averaged at 2c.

For wide ornamental cornices it is hard to set a basis as no 2 are alike. With brackets, capitals, dormers, miters, etc an estimate must be made in detail. If the soffit is ceiled, the ceiling may be taken at 1 sq for 2 men on plain work, and that part eliminated. A miter may be taken at 2 hours for 1 man. Some brackets can be nailed on in 10 minutes; others with moldings carried around them may take from 5 to 10 times as long. Scaffold is not put in, as the one in place serves. If all joints have to be laid in white lead and oil allow a little extra time.

FURRING:—1x2, 16″ centers, 4 to 5 sq, making plugs included. Openings are not deducted unless many and large. For 2x2, 16″, 3½ to 4 sq; 1x2 on ceilings, 16″, 15 sq; 2x2 on ceilings, 12″, 12 sq. No. 9 was furred with 2x4. Put in at regular framing time, as it is easier to set than a partition. The amount given for 2x2 on ceilings is from the actual results all over No. 12. For different spacing allow in proportion on the basis given.

There is a patented "plug" now on the market. It is built in the joint of the brick and the strip nailed in without any cutting. Possibly 1 sq more a day ought to be allowed when it is used.

SHINGLES:—I had seen and worked among slate, tile, lead and thatch, but the first shingle I ever handled was in Vermont. It seemed a curious thing to put on a roof, and I felt sure that it would not hold water. It must have been about 3′ long. The farmer cut his own timber, the carpenter squared it, pinned it, built a huge barn, and covered the roof

with the strange, new wooden slate. We do not use that kind in the west; ours are 16″ long and sawed.

When starting out as a contractor I kept a book and entered the time on different classes of work. Under shingles is found: "On plain roofs, from 4 to 6 squares; on fancy roofs, from 3½ to 4; on plain side walls, about 3." This allowance can not be much improved. Then the standard day was 9 hours; now it is 8, but we do more in an hour. (For number of shingles to sq, see Section 2.)

On a plain roof a couple of "husky" Swedes may put on 8 to 10 sqs, but we stand by an average day's carpenter work—not butcher work—as well as by an average exposure of 4½″ to the weather. It naturally takes more time to lay shingles at 4″ than at 5″. They should never be laid more than 5″,—and it is better to nail them even if the record of 50 sqs for 1 man is not exceeded. On some kinds of walls and roofs 2 sqs make a day's work. The cutting around valleys, chimneys, dormers, bay windows, etc takes a good deal of time. (See Chap on "Painting" for dipping of shingles.)

GUTTERS:—Allow 100 lf for average standing gutters, with all finish got out at mill. With many hips and valleys this figure is too high,—75 is enough. For wide cornice gutters 60 lf may be used as a basis, and the dimension lumber allowed in the regular bill.

Water-table and base	200 lf
Bands and belts	200 lf
Double corner-boards	150 lf

SIDING:—Of old the Medes and Persians had laws that were unchangeable; and the authorities with the siding-hook have a day's work set down in the same hard and fast way. On plain 6″ work 5 sqs is the law for 2 men. On some buildings with long blank walls 8 may be done. On some particular corners again, where Phidias Richardson, Jr., has distinguished himself at the expense of common sense, 2 is a big day's work. A fair average is 4 sqs. Possibly 6 may be done; possibly only 3—not more than 3 if mitered. It all depends upon Phidias.

On narrow siding mitered at the corners allow as a basis 2 sqs, and go up or down according to the angles, dormers, sides, pilasters, hoods, gargoyles, pediments, or walls as plain as a prairie. Unmitered, 3 sq. Scaffolding and tar paper are included; openings are *not* counted, but exact surface taken.

FLOORS:—The usual flooring is 4″ which finishes a trifle less than 3¼. On a 4-story block in Omaha where I was foreman I kept the time on floors. Paper was laid on sheeting and yp floor on top with rough joints smoothed. The whole building averaged 4 sqs for 9 hours, hoisting included. The rooms are of the usual office size, and stores are on the ground floor.

On No. 3 which is also divided into offices, the average for yp was 3½ sqs for 9 hours; but this work was carefully smoothed and sandpapered. It was done by the piece, and the men worked hard on it. They offered to do it at 80c and ended at $1.25 a sq: wages were then 30c. There is a wonderful difference between a long hall and a score of small offices.

Once more we may take time to consider that an illustration of this kind is worth a dozen pages of theorizing.

On joists without an under floor allow 6 sqs of 4″ flooring. The next sentence I find in my MS. is: "On white pine allow about a sq more." It might about as well be left out here, for the ruinous policy of the forest owners has at last practically cleared the northern part of the continent of what is by far the best wood for outside work and fine interior finish.

Flooring 2″ thick, tongued and grooved, may be averaged at 1,000 ft. On No. 4 two men laid 5 sqs in 9 hours, or nearly 1,200′, but that was close to street level. Still that figure is not unreasonable if conditions are favorable. Is the thermometer not to be reckoned with? This flooring is usually 5¼″ finished width. I once knew, however, of 74,000 ft which averaged only 700; and about as much on another building which ran to 1,600, but this was for mill construction with joists far apart. No. 8, 2″ roof, 900.

On warehouses 5 sq are enough if hoisting is included, as it is in all figures given in this section. A common way of finishing warehouse floors now is with ⅞x4″ sq-edged maple. Allow 4 to 5 sq unsmoothed. It has to be double nailed, and takes more labor than yp. The finished size is 3½″. Narrower boards take more time, which is about equal to saying that 2 and 2 are more than 2 and 1; but some of the hasty put 2″ and 4″ on the same basis. But an average of 6 sq is sometimes reached for tongued material which is nailed on only 1 edge.

And now for the proof: On a 6-story building, one of the largest and newest warehouses in Omaha, the yp, square-edged floors averaged throughout 5 sq. On 2 others, also new and large—one the gallery of No. 7—the square-edged 4″ maple ran on the first to 4½, on the second to 5½. The same men laid both, but they had experience on the second.

No. 9 is an interesting building so far as the floors go, for it can be compared with No. 3. Both floors were smoothed and sandpapered, but this one was cut in between the base, and that takes a good deal of extra time as both ends have to be carefully jointed. While aware that some of the best eastern business buildings and residences are so finished I do not like the style. In course of time the joint opens, and the floor is in a worse condition than if a quarter-round had been used, although that is not by any means an ideal finish. In my apprenticeship we tongued the board into a groove in the floor. The knees of the men were reddened before the floors of a house were smoothed and the grooves run.

In the largest rooms of No. 9, on the ground floor where there was no hoisting, 3.2 sq was the amount laid and smoothed. In large rooms the jointing is a simple matter, but not in small ones. In small rooms above, the amount was 2.3 sq, and the general average did not reach 2.5. On the first 8 sq the average was only 1.6 for 2 men in 8 hours. They were first-class mechanics and they worked hard. Much depends upon how a floor is finished. On most of one floor the experiment was tried of smoothing the boards before they were laid, and then merely smoothing the joints, but the work was largely thrown away, for although the

flooring was good and well matched it was necessary to smooth nearly the whole surface over again. The quantity smoothed on the bench was 1,000 in a day. With small rooms, cut in between, and properly smoothed 2.25 is a large enough allowance, although it seems a low one for 2 men.

Dressed and m maple is harder to smooth than yp which was used on No. 9. If unsmoothed allow 4 sq of 2¼ face. Of course more can be laid if on a warehouse as it is all straight work—on a large surface 3¼ sqs were recently laid and smoothed; and 6 without smoothing on upper stories, 8 on ground level. In houses and offices if well smoothed 2 sq are a good day's work. With 1¾ face 1.5 sq may have to pass if the smoothing is well done.

I once helped to smooth an old maple floor 18x90, and with hard work it averaged 2 sq for 2 men in 9 hours.

In an Omaha dining-room, with angle bay window, and border all around, the average in 9 hours was only 50 ft, or ½ sq, but this was a fine parquet floor. It was glued strip by strip, smoothed, scraped, and sandpapered, and there was no time wasted.

In another finished the same way in oak, except for glue, 1¾ face, the cost was $9 per sq at 40c per hour.

On still another house $15 was the figure for oak with a border, and this was over several rooms.

A contractor recently told me that on a fine house where all the floors were of hardwood his average was $12; and on some floors, $15. He watched the men closely, and there was no time lost. The larger the quantity the higher the price, for the men become tired out with smoothing. The common carpenter touches such floors only to spoil them; they require the best tradesmen.

There is a thin floor that many are now using to make the old house look new. At first sight it seems to be much easier to lay than the ⅞, but the difference is not so very great if stuff is grooved. The under floor has to be carefully smoothed to a level surface, and there is more nailing through the face. With varnishing and profit included with carpenter labor these floors are worth about 18c per sq ft in this latitude. A ⅜ "carpet" floor might be laid for half that amount in a square room. In all floors the expense comes with angles and borders. Material of various woods, ⅞″ to 1½ wide, $28 to $85 per 1,000 ⅜″ being counted as 1″, and ⅞ as 1″ wide before dressing, 1½ as 2, 2 as 2½.

Fine floors cost money, and they are usually spoiled by being laid in a damp building. The best time to lay them is a year after the building is occupied. The impatient owner can not wait for style all that time any more than her children can wait for a new toy. In Europe you see floors generations old looking like a picture. In France especially the public buildings shine. Why spoil a lasting pleasure for the sake of a year?

One eastern authority allows $1 per sq for the best hardwood floors; and another, as an extreme figure, 83c. There was once a young man who told his professor that Solomon's proverbs were far behind this en-

lightened age, and that anybody could now make them. The professor instead of reasoning with him merely said: "Make a few."

So much for narrow flooring. Our next stock size is 6", or $5\frac{1}{4}$ face.

For pitched roof without too many angles	3 to 4 sq
For side walls on level	$3\frac{1}{2}$ to $4\frac{1}{2}$
On bare joists	7 to 9
On top of under floor	6 to 7

For white pine, allow 1 sq more.

Of course on porch floors the figures given for bare joists will have to be cut in 2, and sometimes in 3.

Much depends upon the matching of all kinds of flooring. It is sometimes so bad that men working hard do only $\frac{3}{4}$ of a day's work. And again, how high has it to be hoisted? The New York method is to set 20 men one above another at the window of each story and make them hoist it board by board, hand over hand, for 20 stories in the air. It naturally costs more on the 20th than on the 2nd. But our buildings seldom run above 6 stories.

Some estimate floors by the sq and some by the 1,000. More from habit than from any particular merit in the system—when applied to common floors, at all events—I have always taken the square as the unit. The usual allowance for waste and milling is about $\frac{1}{4}$ extra for 4" flooring; a sq, therefore, means 125 ft bm, and thus 8 times the price of a sq gives that of a 1,000. As the square system is almost obligatory on fine floors it seems best to keep to it for common as well.

PORCHES:—The best way appears to be to put framing lumber, sheeting, floors and ceilings in at the usual rate and estimate the rest in a body. There is such a variation in style and finish, and usually such a short time given to make an estimate, that this is the easiest way out of the labor. Of course the roof framing takes longer, but that does not count so much on a complete bill.

As a kind of a basis, a porch 6x22, with plain square posts and flooring roof, hand grooved to run off water, without rail, with average cornice, took 2 men 5 days of 9 hours to make posts, joint cornice stuff and finish complete, the floor being already laid. Several were done at the same time.

On another porch 6x30, of far better style, to make all stuff, 6-paneled posts, cornice, rail above roof, ceiled below, sheeted above, 7 days.

With all millwork made ready, framing, flooring, etc allowed in their place, 5 days extra work is a fair estimate for a good porch without shingles, which go with their own kind. But again, 2 men may work 2 or 3 times as long. How decide without a plan?

GROUNDS:—For wainscoting from $3\frac{1}{2}$ to 4 sq. There is usually no scaffolding required, but they have to be straighter than furring. More can be done on wood partitions and on furring than on brick—about 5 sq altogether. A rough way of estimating grounds is 1c per ft, but with labor at 40c, that is too low. On wood, 1.5c; on brick, 2c is a fair price. A brick opening, 1 side, will take a man 1 hour if he has to plug; on wood $\frac{1}{2}$ hour is enough.

STORE FRONTS:—For fronts about the standard width of 21', like

those in Nos. 5 and 6, allow 5 days to finish complete with sash below, casings, and window shelf inside. With everything moving harmoniously and a half dozen to do at a time, 4 days are enough, but if only 1 is to be done more time is required in proportion. Hardware, transoms, swinging sash below, etc are all to be considered. These plain fronts may be used as a standard. It sometimes happens that a specially good one takes twice as long; and there are others that require only 2 days.

But as with floors there are great differences in fronts. It is possible to design one of standard width that would keep 2 men busy for a month. On such fronts take all plain work on the regular basis and estimate the rest in detail.

WINDOWS:—The time is given for 1 man.

To put average frames together, if stuff comes in the knockdown, 1¼ to 1½ hours. Planing-mill price is only 20 to 40c. An ordinary pine window in a frame building, setting frame included, 5 hours. Hardwood, 6 to 7. If paneled below, 1 extra. In brick buildings with jamb-linings, setting frames included, 6 to 7. Hardwood, 8 to 10. If circle-top inside 1 hour more on pine, 2 hours on hardwood.

The 50- and 60-lt windows in No. 7 were fitted at the rate of 5 in an 8-hour day for 1 man; but half of the work had to be done on a high scaffold. This is a little less than an hour to each sash. The glass was not set, and the work was therefore easier than if it had been.

On more than 100 windows, 30-lt, 10x14,—like the foregoing—the labor ran to 7 hours each. There was no inside finish except a quarter-round. Labor included setting frame, fitting and hanging sash, putting on stops and hardware.

In high windows ¼ to ½ of the time ought to be added; some require twice as long. For a fixed transom 1 hour extra; if hung, ½ to ¾ of an hour more. Of course it is with windows as with other parts of a building,—a detail can be drawn that will put twice as much work on them as is made to serve for the ordinary structure.

For windows hung on sash-balances, allow about 1 hour less,—but sash-balances are fit only for a place where it is impossible to use weights, or for Howling Gulch, Ariz. No. 2 with about 150 windows is fitted with them, although I tried my best to have weights substituted. One never sees balances in modern buildings.

CEILINGS:—The best building codes now forbid wood ceilings in stores and such places on account of danger from fire, which is held back longer by metal, or plaster on ex-met lath.

For plain store ceilings allow 3 sq a day of 9 hours. This figure was taken from work done on several stores, among others those shown in Nos. 5 and 6. Sometimes more might be done, but it is not safe to put an estimate up to the limit. A warehouse with a long stretch is easier to ceil than a store; and a small room takes more time.

As to paneled ceilings it is hard to set a figure. Some have plain beams 8″ wide, and others molded and double molded to a stretch of 3 ft; and panels may be only 1 ft square, or they may be 6. How can we even guess without a plan and detail? And now that we are finally

under roof, is it white pine, cypress, or hardwood finish? The plain work if of ceiling need not be hard to estimate from the base of 3 sq a day, for if it is cut in between beams an allowance can be made for extra labor, which is likely to be twice as much, and for furring, etc outside of the regular joist bearing. A pine beam a foot wide and deep, made of 5 boards—2 about 6″ wide on ceiling, 2 at 12 on sides, and 1 at 12 on soffit, 2 bed-molds and 2 molds at lower edges, may be set at 25c per lf, with scaffolding included, so far as labor on it is concerned. The wall-beam needs to be fitted and may be counted as the others.

But if the panels are small that means many miters. An extra allowance of 40c per miter, or $1.60 for the 4, ought to do this plain work. If of hardwood add 50% to all figures, none of which includes framework.

From this figure of 25c per lf we may go to $10 on some foolish houses. If we go from wood to mosaic we have the price set for the ceiling of the U. S. mint building at Philadelphia at $15 per sq ft. "A fool and his money, etc."

Plain lumber in pine beams larger than a sq ft of section may be allowed at 5c per sq ft bm; and moldings at 1½c per sq in of section with extra allowance for miters. Hardwood, 50% more.

For plain ceiling on walls allow 3½ sq without furring. If of hardwood, 2½.

For cornices and overhangs, 1 to 1½ sq. The wide overhang of No. 11 was done at the rate of 1 sq.

WAINSCOTING:—On No. 12 in 8 schoolrooms, through all halls, wardrobes, etc 2 men in a 9-hour day cut, put up and finished with cap and quarter-round 3½ sq of yp ranging in hight from 2′ 6″ to 6′. On ordinary dwellings and tenements allow about 2½ sq. All material was prepared and furring is not included. If smoothing has to be done allow 6 hours per 1,000 ft for 2 men. They will not be idle—but that average was kept over a large ceiling. This is only 3 minutes to a 16-ft board, 3¼ wide. "I done it myself," and it was done for an employer, not under the piece-work system. Under "Floors" we have seen that the time on 1,000 ft of the same width was 8 hours.

For plain hardwood allow about ½ more time; if there are many angles, 1½ sq for 8 hours.

For paneled work about 4 ft in hight with cap and base allow 50 lf; on hardwood, 35. Sometimes plain work of this kind is easier nailed up than tongued and grooved material, but generally the base and cap are of richer design. It is hard to give a figure on this work as there is a great difference between a plain wall 30 ft long and another broken into 6 or 8 pilasters, each with 4 miters for base and cap. An internal miter if coped, as it ought to be, should not take more than 1 hour on pine, and 1½ on hardwood; and an external one should not take more than half as long; but much depends upon the design, and more upon the joiner.

Furring is not allowed; doors are not counted.

BASE:—With opportunity enough I never happened to keep the time on pine or hardwood wainscoting; but I watched base through 2 buildings. The first was a 4-story block with an unusual number of pilasters,

and they devoured time as 4 miters in a 3-membered base do. Yet all through 2 men put down 100 lf in 9 hours.

On No. 3 with plain rooms 2-membered base scribed to floor, 170 lf. Second floor and basement had oak base which is included in figure. Main floor base on oak, paneled wainscot not included. Doors were not included in either building.

On No. 9, 200 lf of a narrow birch base were laid, but fitting to floor was not necessary.

For plain quarter-round base and q r at floor, 200 to 250 lf. For hardwood, 3-membered, average number of miters, 100 lf;—but it is well to remember that some of our friends from Podunk Creek, even with good intentions and an earnest heart, are practically helpless at hardwood work of all kinds. Nowhere are cheap carpenters so expensive or so exasperating. The old style Yankee carpenter was trained to the tips of his fingers; his successor is a ''Lulu'', and manual training-schools, excellent as they are, do not supply the want of slow, painstaking teaching and practice.

DOORS:—On sliding doors allow framing in regular bill, and 2 days extra to finish complete with lining, jambs, casings, hardware, etc. This will serve for a good pine door well hung; on hardwood, about 3 days. I have known $3\frac{1}{2}$ days to be occupied on a pair of heavy hardwood doors.

As the number of hours does not always divide properly, the time on the following doors is taken for 1 man instead of 2:

For a pair of outside doors about 6′x8′, door-frame, casings, hardware, complete, 10 hours; if hardwood, 14.

Vestibule doors about the same. Both sides have to be cased while front doors have only 1 side, but the jambs and often the doors are heavier, and sometimes a little more elaborate. If with sidelights, give 14 for pine and 20 for hardwood; if transomed, 2 to 3 hours extra. Sometimes a good deal of trouble is caused by boring for flush bolts.

For common pine doors complete, 4 to 5 hours, if $1\frac{3}{8}$; 5 to 6 for $1\frac{3}{4}$. There are those who consume a day to a door and think they do well. If three hinges are used a little more time is necessary. Light closet doors reduce the average and make up for the heavy ones. Some men will hang and put locks on 12 doors in a day; I have often cased 20 sides, but we have to deal with averages.

For hardwood, 7 to 10. Of course a casing of such design might be made as to give 2 or 3 hours extra work; but we are not writing about palaces. I could take any hardwood opening of average size, set jambs, case, hang and finish door in 10 hours, including transom. It is a reasonable allowance. On No. 9 the birch doors took about 7 hours.

For average pine swinging doors, 4 hours. There is no hardware after the hinges are on.

But here we come to another kind of openings: For pine doors and finish of wide, paneled jambs and transoms, 10 hours. On specially high doors, 15 to 16 hours. For hardwood, about $\frac{1}{4}$ more. The hard pine doors with paneled jambs on No. 12 took about 11 hours.

For an opening about 12x16, double swinging doors complete, 2 days for 2 men. They are sometimes used in churches, etc.

For outside double doors, about 12′x18′, in manufacturing buildings like No. 7, 1 day for 4 men. For a sliding barn door, about the same size with iron track, 1½ days for 2 men.

Special doors may be estimated from the foregoing figures, which would be considered very liberal by a New York "lumper". While living in New York I was told of some who steadily fitted 36 doors, and left the hanging of them to some brother in misfortune. On cheap buildings they certainly do far more work than western carpenters, but their work has 2 drawbacks—it is worthless in quality, requiring repairing almost from the time it is finished; and it is making white slaves. A good carpenter goes to lumping only as the last resort.

Grounds are not included on either doors or windows.

STAIRS:—Setting only is allowed,—not millwork. But which style shall be selected? I have known 2 men to set a stair in a forenoon, and again, work on another for about 2 weeks.

On No. 12 with regular school stair, double flight, ceiling rail, about 6′ wide, 3½ to 4 days.

On No. 2 it took 233 hours for 1 man to set and finish 3 flights of oak stairs about 5′ wide, with continuous rail.

On No. 9 with oak stairs of a better design it took 300 hours for 1 man to set 3 flights. Platforms allowed in framing lumber.

For a long box stair without landing, 1 to 1½ days for 2 men. Box stair for cellar or attic, about the same if winders are used. For a plain 6- to 8-room house, 2 to 3 days. For a fine stair to a house of 8 to 10 rooms, 6 days.

Guess the rest; and remember that although the estimate may not be mathematically correct, you may add to or deduct from a reasonable percentage on complete bid enough to build the stair complete. While admitting that an estimate should be as nearly correct as possible why insist on absolute accuracy on one small item and then make a wild guess at the profit?

Of course there are stairs that would keep 2 men working for a couple of months, or even a year. The Glasgow people have a fine stair in their new municipal buildings,—one of the best I have ever looked upon. But the best, the stair that once seen is never forgotten, is the "Stairway of Honor" in the Grand Opera House, Paris. It is wide enough for teams to drive up abreast. "The steps are of white marble, the balustrades of alabaster, the hand-rail of African onyx. Twenty-four colored marble columns rise to the hight of the 3rd floor." And so on they describe the marvel in the $7,000,000 Opera House,—and that price too where wages are low. I did not even try to estimate the time required to build it. The house itself took 14 years,—and it will probably last for 1,400.

SIDEBOARDS:—We have some that fill the end of a large room, and others not so great in size or style. One of ash, I remember, 8x8′ with drawers, doors, brackets, shelves, mirrors, and hardware to match. Two men took 8 days to complete it. Another of oak about the same

size, 6 days. The difference was a matter of detail. Millwork for both came in knockdown,—and here it may be worth while to say that there is a good deal of difference in the way millwork comes. The cheapest mill bid on stairs, sideboards, window-frames, drawer-cases, etc, may mean 10% more work when the stuff is delivered.

A fairly good sideboard may be set in 4 days; none in Omaha, I judge, would require more than 10 to 12. Bishop Spalding says that "We build big houses to hold little men." The size of the sideboard, as it were, does not indicate the size of the man, but why should we preach in a book of this kind?

CHINA-CLOSETS:—Allow from 2 to 6 days.

PANTRIES:—From 1 to 4 days.

A china-closet might come put together, leaving only the labor of pushing it into place and nailing a casing around the opening, all of which might be comfortably done in a day; but most of them come in the knockdown. There is a difference between one pantry with only half a dozen of plain shelves and another with shelving all around, meal-bins, drawers, etc; one may have only 20 sq ft while the other has 3 or 4 times as many.

STOREROOMS:—Put in shelving at 24 sq ft per hour for 2 men. On No. 2 I kept time on 3,000 ft all dadoed by hand into compartments about 18″ square, and the average was higher than this which seems safe. But I know of nearly 60,000 ft that did not average 16 ft with far less dadoing. Pantries, closets, etc, may be figured by this method and an allowance made for extra labor,—but 40 to 50 ft seems fair as there is no dadoing.

BLINDS:—Outside, for either brick or frame buildings if fitted before frames are set, 20 pr average size; if after frames are set 14. Inside, 4 to 5 sets a day for plain work; hardwood, 3 sets.

Section 2
MATERIAL.

GIRDERS:—It is not necessary to say anything about girders, for they can not well be missed unless through carelessness. By reference to the chapter on "Standard Sizes" it will be seen that all dimension lumber must be ordered of even lengths; although a girder or joist is billed at 11 ft 12 have to be paid for, so that there is no economy in putting down odd sizes. But it sometimes happens that 2 odd sizes are required of such lengths as may be taken out of an even size, and thus 2 lf are saved. An 18 ft, for example, will make 11 and 7.

JOISTS:—It is of some importance to watch the spacing of joists and the ordering of lengths of flooring, etc to suit. Many architects space to a partition, put in the double joists and then space from them. If this is repeated several times there is apt to be a good deal of trouble with lengths of sheeting, flooring, ceiling, lath, etc, for the joists might be so placed as to waste the even lengths of lumber clear across the room. It is best to space from one end of a building and stick to the regular spacing unless for some special reason. Allow extra joists for doubling where they are required on this basis. The double joist may come so near the regular spacing that a little variation will not be of much consequence.

To get the number of joists required count them and add 1 extra for main rooms and doubles wherever necessary. A carpenter does not often use an architect's scale for taking off quantities although it is the best article for the purpose. If the joists are set 1 to the ft, and the plan drawn to $\frac{1}{8}$ or $\frac{1}{4}$, by laying on the scale the number can be seen at once without any mental calculation. If centers are 14″ or 16″ a slip of paper can be laid off from the scale and moved from room to room adding the extra joist.

Still for 16″ centers a carpenter's rule is as good as a scale, for the even figures multiplied by 3, and 1 added, give the number. Suppose a room is 32′ long at $\frac{1}{4}$ scale; the rule would show 8, which multiplied by 3 gives 24, and 1 at wall, 25. A trifle over the even figure means an extra joist, for at 16″ centers 20″ needs 2 just as much as 32. As there are 3 to the inch the exact number can easily be seen although the even figure is not on the line. Each room divided in such shape that the floor stops, as at a brick wall, requires an extra joist. An extra ceiling joist is often needed where there is a partition—sometimes 2 are insisted on; but there are architects who are satisfied with a strip to hold the end of the lath.

STUDS:—For walls and partitions allow 1 stud to the ft for 16″ centers. This seems too much; but after allowing plates in addition I have sometimes run short. A 2x4 can be used for a score of purposes apart altogether from partitions and walls; but if doors, windows, arches, etc are all properly doubled and corners made solid so that lath can not pass through, and if proper base-blocks are nailed in, the allowance is not too much unless on very plain work. Of course a stable or shed does not require such doubling. The nature of the building must be considered. When ex-metal lath is used doubling is not necessary as it bends to the shape of the corner and when plastered becomes as hard as a rock, but base-block are still needed.

Much depends upon the times: one can miss a few pieces when prices are high, but not when they are cut to the bone. I remember accidentally leaving out a whole floor of partitions in a block of 3 flats—one of No. 6. Had the stuff gone in, another contractor would have got what proved to be a nice little prize of more than $2,000, for the difference in the bids was only $60. This experience is introduced not to encourage such omissions on the chance of getting rich, but rather to emphasize the fact that several buildings or floors on the same plan are dangerous. One floor is estimated and the intention is to mult by the number, but we switch off and forget.

CREOSOTING:—From $15 to $20 per m.

BRIDGING:—Joists are almost always bridged, and studs are occasionally. If bridging is taken separately a close enough price may be found in Part 1. The lengths may be found there also. As a rough and ready way out of this small item which, however, can not be overlooked, I allow 3 ft to every lf, and seldom find much left. Windows have to be braced, ladders made, and other matters attended to.

RAFTERS:—On a plain roof it is simply a matter of counting them the same as joists and adding 1 extra. There is more trouble on a roof like

No. 11 with angles, hips, valleys, and dormers. It is of some importance to get the right lengths of hips and valleys. They are better billed 3 ft too long than 6″ too short, for the strength of a roof depends upon them. Before setting down the lengths it is safer to lay the plan of the rafter on a piece of paper if not sure of the ground. If there is a plan of the roof it is only necessary to square up from the line of the hip or valley, set off the same hight as the common rafter at any point desired, whether at the ridge or below it, if the hip or valley does not extend clear through, and then measure the distance between the 2 points. To use 3 common figures, well known to carpenters who square houses by them, if the line of the h. or v. on the plan measures 8, and the hight or rise is 6, then the h. or v. is 10 ft long. This is the secret of taking off the lengths of lumber for any roof: Get the distance in from the wall-plate and the rise from the level, and measure the length between the 2 points. The same rule holds for jacks and cripples. A liberal allowance must be made for complicated roofs. For every 12″ of common rafters on the plan a hip or valley at an angle of 45° has 17″.

A good method of testing the length of any rafter is to get the run and the rise, and extract the square root,—and this is about the only use I have ever found for that arithmetical triumph which in school-days caused us more trouble than all it is worth, for it is only in case of doubt that I think of using it. Lumber bills in thousands, and roofs by the acre, have been finished by those who never heard of such a thing, who do not know that the useful 8, 6, 10; and 12, 12, 17, are hinged on the same principle.

The pitch of a roof is taken from the level of the walls to the ridge. A common way of building roofs is to use a standard pitch. A $\frac{1}{4}$ pitch is $\frac{1}{4}$ of the span over the walls; $\frac{1}{3}$ is $\frac{1}{3}$ of span, and so on. Thus a 24-ft span would on $\frac{1}{4}$ pitch give a rise of 6 ft. I ran across one rule in a book which seems good enough to copy: "To get the length of rafter for $\frac{1}{4}$ pitch, mult span by $\frac{7}{12}$; $\frac{1}{3}$ by $\frac{3}{5}$; $\frac{3}{8}$ by $\frac{5}{8}$; $\frac{1}{2}$ by $\frac{7}{10}$; $\frac{5}{8}$ by $\frac{4}{5}$." The $\frac{1}{2}$ pitch rule would be 2″ short on a 24-ft span; but in all cases the projections of rafters for cornice has to be allowed extra, and that would take care of this shortage.

Ties, wall-plates, ridges, lookouts, molded rafters, and other subordinate parts of a roof have to be attended to. It is not hard to overlook them.

Nothing need be said about the lumber on roof trusses, for it is easy to take off. Rods and bolts are as easily seen as lumber.

SHEETING:—Get exact surface to be covered after deducting openings and allow $\frac{1}{7}$ more for floors, $\frac{1}{6}$ for side walls, $\frac{1}{5}$ to $\frac{1}{4}$ for roofs. Sheeting like 2x4's covers a multitude of holes and corners.

Sheeting and shiplap are sometimes nailed on an angle on side walls and floors: add 5% to previous figures for the waste, as each board has to be cut at both ends. Sheeting is sometimes left 2″ open on cheap roofs, and a deduction should be made accordingly. On plain roofs the quantity may not be more than for floors.

SHIPLAP:—Get exact surface and allow $\frac{1}{6}$ for floors, $\frac{1}{5}$ for walls, $\frac{1}{4}$ for roofs. Some roofs need more. See under "Floors" an illustration

of how to get quantities. On purlins, and joists in mill construction, lengths must be watched owing to wide spacing. A roof with only a 40′ slope might require 46′ of lumber, or a waste of nearly 2′ on the end of each board.

CORNICE:—With the detail that ought to accompany the main plans, but usually does not, there should not be any trouble taking off the cornice lumber. If it is white pine be sure to get the price before estimating. The cornice for a common frame building generally has a sectional area of about 3 ft; some are less. Allowance must be made for miters at all corners. On cheap buildings the frieze is only $\frac{7}{8}$ thick; on good buildings it is $1\frac{1}{8}$, the same as the corner-bds. Base, corner-bds, bands and such trimmings are easily seen.

SHINGLES:—I recently estimated dimension shgs for 61.6 sqs of surface without a break, or even a chimney. At $4\frac{1}{2}$ exposure the actual number used was 53,500, or 868 per sq. This will serve as a basis. On another plain building with the same exposure, 860 were used. On some roofs, gables, and walls, 900 are necessary.

At 4″ allow 990; at $4\frac{1}{2}$, 880; at 5, 792, for the plainest surfaces.

At 4″ allow 1012; at $4\frac{1}{2}$, 900; at 5, 810, for cut-up roofs.

If 6 to 2″ shingles are used about 3% more than 5 to 2 are required. The 6 to 2″ are not only thinner but narrower, and the waste is greater.

We have many authorities on shingles. I have more than half a dozen at hand, and except one they are all the same with quantities. "To 5″ exposure, 720; $4\frac{1}{2}$, 800; 4, 900." They have been copying one another. Now it is far better to copy what is right than to be original with what is wrong, but the quantities they give will not hold out. They make no allowance for narrow shingles, and the saw can not cut without waste here any more than with other lumber—the bunch which should measure 20″ is now only $19\frac{1}{4}$ and 19; and sometimes a shingle is lost or broken. The figures are mathematically correct, for at $4\frac{1}{2}$ exposure a shingle covers 18 sq inches, 8 to the sq ft, 800 to the square. But what about cutting for an angle? What about the width of the saw-cut on each piece? What about the double course at the eave? With varying widths and qualities the exact quantity may not always be struck, but the mathematical process will not do.

GUTTERS:—The plain finish lumber is easily seen in section, and the bottom is usually of sheeting. The millman attends to brackets and moldings.

SIDING:—Deduct all openings and add $\frac{1}{3}$ to the surface in sq ft for 6″ siding at $4\frac{1}{2}$ to $4\frac{3}{4}$ to the weather. If all boards were kept at $4\frac{1}{2}$ and there were many gables with the usual waste this quantity would be a trifle short. For 4″ siding allow $\frac{1}{2}$ more than surface after deducting openings.

By following the method explained under "Floors" we can arrive at the quantity for any exposure. Take for illustration a space 100′ long and 9′ 9″ high. For 6″ siding at $4\frac{1}{2}$ we have 26 bds in hight and each bd is 100′ long. This is 2,600 lf, or 1,300 bm, no waste being allowed for cutting on end. The space lost is exactly $\frac{1}{3}$ of the space exposed; but gains are made at corner-bds, casing around openings,

etc sufficient to make up for cutting, although the quantity is a trifle close. Of course the exposure is sometimes stretched $\frac{1}{8}''$. Take for narrow siding the same length with 9′ 7″, to allow for even spacing at $2\frac{7}{8}$. Forty bds are required 100′ long, but each bd is only $\frac{1}{3}$ of a ft wide and the quantity is 1,334′ bm, or the actual surface mult by 1.39, or a little less than $1\frac{1}{2}$ At $2\frac{3}{4}$ exposure we have to use 1.46; at $2\frac{5}{8}$, 1.53; at $2\frac{1}{2}$, 1.6.

For drop siding allow as for flooring of same width, or proceed as explained.

PAPER:—See Index for wt of tar paper, etc. I always remember one rule that is safe, and close enough for average paper:—Allow $1\frac{1}{2}$ lbs to the sq yd. But this is too much for some papers.

FURRING:—Allow 1 to the ft when spaced at 16. Less may do, but a fire-stop is now obligatory in most cities, and there is sometimes a good deal of waste by breakage. Where 2x2's are used the chance of breakage is reduced, and 1 to 14″ is enough for ordinary work. As with joists an extra piece is required for each room, for only on cheap houses is lath run through. The figures given in Part 1 are safe if taken by the sq.

GROUNDS:—It is easy enough to find the number of ft for doors, windows, wainscoting, etc. Grounds are so easily broken and there is so much waste that 7 to 10% extra should be added. It is well to remember that for wood lath they should be of $\frac{7}{8}$ stuff; for brick or fire-proofing only $\frac{5}{8}$; and in both cases they must be surfaced 1 side. The thinner the ground the better will the plasterer like it.

FLOORS:—On the floor of No. 7, 3″ thick, I was a little curious to know how much an old contractor, for whom I had worked 4 years, had allowed, and I asked him,—"190,000 ft." My figure was 189,000. Owing to lengths of plank which did not suit the spacing of joists, the quantity required was 190.000,

It is a fairly easy matter to get at a plank floor. Unmatched lumber measures about $\frac{1}{2}''$ less than the standard size; therefore, if the plank is 6″ it is clear that $\frac{1}{12}$ of it is lost, no matter what thickness; and this without making any allowance for waste the long way, owing to spacing of joists, bad ends, etc. An allowance of $\frac{1}{9}$ extra covers 6″ stuff.

There is an excellent way to check plank, flooring, ceiling and material of this kind if the exact width is known. Take for illustration a floor 100x200, and suppose that joists are spaced to obviate any loss on end. There are 219 planks required if $5\frac{1}{2}$ is the exact width. Each plank is 200′ long. This makes 43,800 lf at 2″ thick, and as each ft in length makes a ft in bm, this is the quantity, nothing being allowed for waste on end. No extra measure has to be allowed as the waste in width is made up by the number of planks, for at exactly 6″, only 200 are required. At $\frac{1}{9}$ extra, 44,500 is the amount. A 12″ plank measures about $11\frac{1}{2}$, so that in proportion there is less waste than on 2 at 6, but the sidewalk, floor, or wall, is not so good.

On a large surface with a thick floor $\frac{1}{8}''$ less in width means a larger lumber bill. It would be more than 4,000′ in No. 7. Thus we can not in all cases expect to get exact results. But one point should be re-

membered here. Take the exact surf of a room,—say, 30x56, or 1,680 sq ft. Let flooring be 3″ at the mill, finishing $2\frac{1}{4}$ face. An allowance of $\frac{1}{4}$ seems to be enough, for the $\frac{3}{4}$ used in sawing and milling is only $\frac{1}{4}$ of the 3″ rough lumber. But $\frac{1}{3}$ is required, even with no waste on end, because the $\frac{3}{4}$ wasted is $\frac{1}{3}$ of the *finished* surface of $2\frac{1}{4}$, and there is that much loss. The quantity is 2,240 without loss on end.

For 235 sq of square-edged maple 29,000′ of flooring were used. This is a trifle more than $\frac{1}{5}$ extra. As the boards were exactly $3\frac{1}{2}$, there was only $\frac{1}{7}$ of loss, but the end cutting and other waste makes up the difference.

So much for plank and square-edged material; what follows is for d and m stuff.

On No. 3 there were 262 sq of 4 flooring. The amount used was 31,616′, or $\frac{1}{4}$ more. But there was a gain of 8″ at each cross partition, and this counts in such a building, for in this case the area includes them. If there is any prospect of waste through bad spacing of joists, etc, a fair allowance is between $\frac{1}{4}$ and $\frac{1}{3}$, or $\frac{7}{24}$. When there is a good under floor the waste is not so great, as the floor is sometimes nailed down regardless of the joist bearing, and this saves material.

On No. 2, where there was no gain on partitions and some waste on end, as there was no under floor, the amount for 3 floors,—157.2 sq—was 20,850 ft, or a little more than $\frac{7}{24}$.

For 6″ floor'g, $\frac{1}{6}$ extra; $2\frac{1}{4}$, fully $\frac{1}{3}$; $1\frac{3}{4}$, $\frac{5}{12}$. There is always a floor below narrow stuff, and if it is of good quality the waste need not be much in excess of the milling allowance.

CEILING AND WAINSCOTING:—Make same allowance as for flooring. Take off plain lumber in the usual way, always remembering that 2″ more than 12′, 14′, 16′, and even figures means a board 2′ longer.

Some attention must be paid to the length of ceiling as it may cut to a good deal of waste. Occasionally one finds an architect who has never heard of standard sizes, and for the sake of 2″ in hight he wastes 2 ft of lumber.

MOLDINGS, etc, go in millwork.

PORCHES:—The framing lumber, sheeting, shingles, flooring, ceiling, and plain finishing boards are taken off as on other parts of a building.

FINISH LUMBER:—Shelving for storerooms, pantries, etc; steps and risers for stairs; door-jambs, jamb-linings, etc, if not included in millwork can be easily taken off. Millmen seldom take off plain lumber.

CHAPTER X

MILLWORK AND GLASS

The following prices do not include putting work in place. Any one engaged in building may have for the asking a "Complete Pocket Catalog" of millwork with about 200 pages of descriptive matter. It is not necessary to reprint it here. All that will be attempted is to give a price on a few selected sizes, so that in case the millbook is not at hand a fair idea may be obtained of any size in proportion to that listed. Of course prices change from year to year, and at different seasons of the year; but stock stuff remains close enough for our purpose, and a reasonable margin should be allowed on odd work as no two mills figure

it at the same price any more than two contractors. The present discounts from the mill book are:

Doors, 60% off list; open sash, 60; glazed sash, 70 and 5; yp moldings, 60; wp and cypress, 50. May, '04.

Freight has to be watched on country work. Glass is included in lists, as it is usually supplied by the mills.

SASH:—(See "Moldings" for price of stiles and rails.)

12 LIGHTS:—Check-rail, 8x12, glazed single strength, $1.20 per window; 9x16, $1.75; 10x20, $2.40; 12x20, $2.70.

8 LIGHTS:—9x12, $1; 10x18, $1.65; 12x20, $2; 14x24, $2.85; ss.

4 LIGHTS:—10x30, $1.35; 12x40, $2.10; 14x32, $1.80 ss, $2.50 double strength; 14x48, ss $3.30; ds, $4.20; 15x48, ds, $4.50.

2 LIGHTS:—16x32, ss, $1.20; ds, $1.60; 20x40, ss, $1.90; ds, $2.40; 24x48, ss, $3.30; ds, $4.10; 28x40, ss, $2.30; ds, $3; 30x50, ds, $4.65.

The foregoing prices are for 1⅜ thick; for 1¾ on the last and largest size given, add 50c; and from that down to 25c on the smaller sizes. Add 20c per window for oil finish. Glass is marked AA, A, and B; AA is selected from A and is seldom used. A is common and good enough for most purposes. B is often used in place of A.

A 30-light window, 10x14x1¾, ss, is worth for sash, $5.25; for frame, $3.50. When frames are bought it is necessary to see whether they are in the knockdown or nailed together.

For sash veneered with oak allow 50% more than the prices given after deducting glass which is the same in both kinds. There is a list with nearly 100 sash extras in the mill book.

Storm-sash 1⅛ thick cost the same as 1⅜ windows.

For those who want a close approx figure the following sq ft prices will be useful. Take the inside size of window-frame, or glass size including sash. Sash 1⅜, primed, not for oil finish. For 12-light windows, ss, allow 12c per sq foot.

For 8-lt, ss, 11 to 12c.

For 4-lt, ss, 12 to 14c; ds, 16 to 18c.

For 2-lt, ss, 13 to 15c; ds, 18 to 19c.

These prices are taken at present discounts, but 1c a ft on a window of fair size amounts to only 21c, so that a little may be added by those who rely upon this sq ft base. Of course the list figure is cut on a large order. On the 30-lt window already given, for example, the cost of 1¾ sash was only 15c per sq ft. On several large orders in 1902 of 50- and 60-lt windows, 10x14x2, ss, including box frame complete, but no finish, the cost was 22c per sq ft,—but a margin is desirable as conditions are not always the same.

WEIGHT OF SPECIAL SASH:—It is unnecessary to set down here the weight of standard sash, as the mill books have complete lists; but it is sometimes difficult to ascertain the weight of odd sizes, and the following figures will serve as a guide:

From a general average taken over the mill lists of 1⅜ wp stock, I find that a fair allowance for the wt of wood is 1 lb to the sq ft of glass. Sometimes the small sizes are a trifle more, the large ones a trifle less,—say 1-10 of a lb either way,—but the variations in the wood or glass

make 1 lb a safe allowance. If $1\frac{3}{4}$ sash are used allow extra in the proportion of 11 to 14; if hardwood inside, allow w't as compared with wp.

The glass varies a good deal; the average of the mill lists is $1\frac{1}{4}$ lb for ss, and $1\frac{1}{2}$ for ds to the sq ft; but on some sizes ss runs from 1 to 1.6 lb, and ds as high as 2 lbs. The proper method is to weigh all sash, but sometimes this is not done. Averages for the foregoing figures were taken over 1,500 sq ft of glass.

The following w'ts were obtained from a large number of sash put in place, the small sizes on No. 7; the large on No. 1:

60-lt	windows	10x14x2″,	ss, 150 lb	2-lt	windows	28x50x$1\frac{3}{4}$	ds	48 lb
50-lt	"	10x14x2″,	" 134 "	2-lt	"	24x60x$1\frac{3}{4}$	"	52 "
40-lt	"	10x14x2″	" 106 "	2-lt	"	28x60x$1\frac{3}{4}$	"	64 "
30-lt	"	10x14x2″	" 76 "	2-lt	"	30x60x$1\frac{3}{4}$	"	76 "
2-lt	"	28x40x$1\frac{3}{4}$″	ds 40 "	2-lt	"	40x60x$1\frac{3}{4}$	"	80 "

As in the regular lists the total has to be divided by 4 to get the sash weight.

DOORS

CUPBOARD DOORS:—16 to 20c per sq ft in yp; in oak, $\frac{1}{3}$ more.

OG 4-PANEL DOORS:—A quality: B doors are about 10% less. For oil finish add 50c. The mill book has a list of 40 "extras" in doors.

OG, 4-pan, $1\frac{3}{8}$, 17 to 18c; 20c for the largest sizes.

OG, $1\frac{3}{4}$, 26 to 28; largest sizes, 30 to 35c.

OG, 5-pan, $1\frac{3}{8}$, 16 to 18; largest sizes, 20 to 22c.

OG, 5-pan, $1\frac{3}{4}$, 26 to 27; largest sizes, 30 to 35c.

Raised-molded doors, 4-pan, $1\frac{3}{4}$, 1 side, 35c; 2 sides, 40c. There are a hundred varieties of these common doors, and also of front doors which run from 50c to $1 per sq ft, depending upon style. For front doors the glass has to be added extra. It may be made to any style or price.

Oak and ash doors for inside run from 38c to 40c per sq ft from $1\frac{3}{8}$ to 2″ thick. For each $\frac{1}{4}$″ in thickness over 2″ add 2c per sq ft. If more than 5-pan, add 15c for each pan extra. Unselected birch doors from 30 to 35c; if only $1\frac{3}{8}$″ thick, 25c. Unselected birch, $40 and even less; selected $50 to $60 per M.

Plain store fronts, 20c per sq ft taken over entire surface but no glass included. They should properly be priced in detail. Stock store doors alone are worth from 30 to 40c per sq ft unglazed.

Heavy square doors for such buildings as No. 7 are worth from 23 to 25c per sq ft. Each half is 6′ 4″x18′. At this price they are lined on one side on a framework of 3″ material, and a large sash is put in each half. If circular top add 1-7 to price. Of course a single door would cost more than a large order.

BATTEN DOORS:—7 to 10c per sq ft, wp ceiling 1 side.

FRAMES:—For windows about 3′x7′, $3.25 to $3.50, box. On frame buildings, 2x4″ studding, put together, $2.25; brick bldgs, $2.75. The price may run as high as $4, depending upon the style and size; and this without going into hardwood, which is 30% higher. Average pulleys are included.

OUTSIDE DOOR-FRAMES are about the same price; with transom,

\$3.50. From 25 to 40c is charged for nailing frames together in the mill; on the building they cost about twice as much. If oak sills are used, add from 40 to 50c. White pine is by far the best wood for outside frames, but it can scarcely be obtained now, and the price is high.
INSIDE DOOR-JAMBS:—Studs 2x4, door 3x7, white pine, 70c; cypress, 80c; yp, 60c; oak and ash, \$1; add from 30 to 50c for transom. These prices are for ⅞ jambs. For 1⅛, add 15%. For 6″, add 25%. Add door- and window-stops to figures as they are not included.

OAK THRESHOLDS, 6c each up to 3 ft.

JAMB-LININGS:—Take door-jambs as a basis, as labor and lumber are about the same for ⅞ material.
BLINDS:—Outside, rolling-slat, 1⅛, 9 to 10c per sq ft. Inside:—(Pine) 2′ wide, 45c; 3′, 3-fold, 55c; 3′, 4-fold, 70c; from 3 to 4′, 4-fold, 75c; 3 to 4′, 6-fold, \$1. The sizes on inside blinds are for hight and not by the sq ft. For hardwood:—30% extra for oak, ash, birch and maple; 50% for cherry and walnut.
VENETIAN BLINDS:—12 to 15c per sq ft.
BLOCKS:—The varieties of base- and corner-blocks are so many that a price can not be given. In yp 3 to 5c buys a fair corner-block; in hardwood, 6 to 7c, but the cost may be 5 times as much according to the pattern. Base-blocks, yp, 4 to 5c; and 6 to 8c for hardwood of common pattern.

Round corner-beads for plaster, 10 to 15c each in pine; 25 to 30c in common hardwood.

MOLDINGS:—The mill book has about 400 different styles—and each of these may be run in 20 different kinds of wood. However, we can give a few hints for an emergency:—

For all door- and window-casing allow in yp ⅝c per inch of finished width; in birch, ¾c; in oak or ash, 1c. This is on the basis of lumber ⅞ thick. If casings are thicker, reduce to bm and estimate as before. In large quantities ½c is enough for yp and cypress, and ⅞ for oak.
BASE:—The same prices will cover base—but this is a good place to remind all interested that these prices may be justly doubled and quadrupled if stock patterns are not used. If each room in a house has its own pattern special knives have to be made for its 50 ft just as for 5,000 of stock.

Unsmoothed yp casing to 6″ wide is listed at 2c per lf; 8″ base at 3c; 10″, 3½, so that the foregoing prices are safe for smoothed work. New mill-run casing 5 and 6″, \$33 per M ft bm; 8 and 10″ base, \$35.
WINDOW-STOOLS:—These are usually 1⅛ thick. At that thickness allow in wp 1c per inch of finished width; in w oak, 1¼; ⅞x3″ pine, 2c per lf.
WINDOW-STILES AND RAILS:—1⅜ wp, 4c per lf; 1¾, 5c. Check-rail is less, bottom more, but average holds.
STOPS:—Door- and window-stops run from ½ to 1¼c, depending on width which is from ⅞ to 2½.
NOSINGS FOR STEPS:—From 2 to 4c in pine.
WINDOW-SCREENS:—8c per sq ft; door, 8 to 12c.
BATTENS:—⅜x3 flat, 40c per 100 lf; og, 2″, 55c; 2½, 65c.

With the exception of a few of deep cut all moldings may be estimated at the prices given for casings and base.

PANELING:—For yp, 20c per sq ft; birch, 30c; oak, 30c for plain red to 40c for qs white. However, the size of the panels and the style of the molding have to be considered. Unselected birch is 10% cheaper than oak; cherry and walnut are 50% more expensive than plain oak. Paneled door-jambs may be put in at the same rate if there are several sets.

Add cap, base, shoe, bands, etc, for wainscoting.

For yp office partitions 7′0″ to 7′-6″ high with chipped- or maze-glass panels above allow per lf $3 to $3.50; in plain oak, $4 to $5.

Plain matched and b red-oak wainscoting is worth $60 per 1,000 ft bm; machine-sandpapered, $5 extra. For plain-oak finish allow $90 per 1,000 machine-run and cleaned. The paneled-oak wainscoting in No. 3 was put in at a trifle less than 50c per sq ft. It was 8′ high.

STAIRS:—Box, average width, pine, housed, per step, $1.40; plain oak, $2.10. Open stair, pine, per step, $1.60; oak, $2.20; oak with paneled string, $2.85. Add rail in yp, 15c; oak, 25c. Each crook in rail, $3.50. Paneling at regular price for square work, and 20% more for work on rake. Winders in pine, 40c extra; in oak, 60c. For large, circle starting-step, $5. Newels and balusters to be added.

These prices are for plain stairs; others have to be figured in detail. Cellar and plank stairs may be estimated by taking off the plain lumber and allowing labor at $30 per 1,000 in addition.

NEWELS AND BALUSTERS:—Allow on 1¾ yp balusters, from 10 to 12c; oak, 12 to 14c. This is for stock and plain turning; spiral work costs about twice as much. Stock newels run from $5 to $10; oak is about 10% more than pine.

HAND-RAILS:—In yp 12c for 2½x4; in oak, 20c. The price of circular stairs may be put at 3 times that of plain ones; and there are stairs which easily cost 10 times more than what would be accepted as a reasonable standard. It all depends upon the detail.

GRILLES:—These run in yp from 75c to $2 per sq ft. For special patterns and work $5 may be required. As there is little material required the difference between pine and hardwood is not so great as in other mill products. Allow 10% more for oak.

PORCH POSTS:—The lengths run from 9 to 10′ with a slight difference in price for extra lumber: 4x4, 90c to $1.25; 5x5, $1.25 to $1.75; 6x6, $1.50 to $2.75. A fluted post, 75c extra. A colonial post, 10″ diam, $5 to $6.50; fluted, $1 extra.

PORCH NEWELS:—60c to $1 each.

PORCH BALUSTERS:—Allow from 6 to 10c apiece for ordinary turned stock.

SPINDLES:—In stock patterns, from 3 to 4c each.

PORCH RAILS:—From 4 to 10c per lf in stock.

BRACKETS:—In stock, 10″x12″, 12 to 20c each at 1½ thick; 2¾, 50c; 3½, $1.50.

CRESTING, all kinds of fretwork, gable ornaments, gutter-ends, finials,

etc are neither worth pricing nor putting on a building even if furnished for nothing. The heat and rain wreck them in a few years at longest.

PLAIN COUNTERS:—Take off all material and estimate labor in detail. Ceiling, shelving, etc come under ordinary rules. For all circular millwork in general allow 3 times the price of straight. Money drawers, $1.50 each. Common drawers, average size, $1.

ODDS AND ENDS:—In general, millmen are like other tradesmen when estimating on special work—they take off each item separately. It is a slow process to take off each piece of lumber, but it often has to be done as it is the only sure way with special work. The labor is a matter of judgment.

SQUARE PICKETS are worth 2½c each; flat, a trifle less.

CASES of ⅞ material from 12 to 16″ deep with doors, 60c per sq ft of face surface; of ⅜ stuff with pigeonholes about 4x8″, as in ticket-cases, etc, 25c per opening.

SURFACING:—For timbers, $1.25 each side; boards, $1.50, and $2.50 for 2 sides. Hardwood, 60% more. These prices are per 1000 ft bm.

CROWNING JOISTS:—$2.50 per M for two edges.

CUTTING BRIDGING:—$5 to $6 per M bm.

OAK-FLOORING:—Red, $55; white, $60; quarter-sawed, white, $80. Quartered red, $75;—all ⅞; ⅜ qs white, $55.

MAPLE, ⅞, $30 to $40; ⅜, $32.

PARQUET FLOORS AND BORDERS:—There are many patterns, and the prices differ. In my apprenticeship I worked so long among these floors that the look of them wearied me. They are made up of small pieces in an endless array. Then the only thickness was ⅞; but now a popular thickness is 5-16. This thin floor can be laid without cutting doors in old houses, and this accounts in part for its popularity. Parquet borders are often used and rugs placed in the center of the room. It seems a better way of finishing a house than carpeting all over, but tastes differ.

All oak is white, quartered, in the following lists: Price per lf for strip borders, 5-16.

Oak	Under 2″, 1c
Cherry	1½, 1.2c; 2, 1.8c
Mahogany	1½, 2.4c; 2, 4.2c
Walnut	1½, 1.2c; 2, 1.8c
Oak and Mahogany	1½, 3 c; 2, 4.8c
Oak and Walnut	4, 3.6c; 6, 5.4c
Oak, Walnut and Cherry	6, 7.2c; 8, 10 c

Strip borders are not listed wider than 8″, although they may be made of any width or of any combination of woods.

Parquet borders, 5-16, per lf,—not sq ft.

In oak alone, 5″ wide, 10c; with 2 or 3 other woods, 12 to 15c.

At a width of 8″, oak only, 15c; with other woods, 15 to 25c.

At 12″ wide, 2 to 4 woods, 20 to 30c.

At 16 to 18″, 25 to 38c, but some woods of same width, 40 to 50c.

Some woods at 20″ may be had as low as 30c and as high as $1.

At 24 to 30, 75c to $1.25.

Corners for borders are about 50% more than straight material.

Borders are made in 12′ lengths; fields, 4′.

Sizes are paid for before cutting, and this waste has to be included in price.

PARQUET FIELDS:—The price of the field or "body" is given in sq ft. There is not so much difference between prices of fields as with those of borders. They are hidden by the rug and may be plainer. They run from 15 to 20c, but some are as high as 35c. These thin floors sometimes come rolled on a canvas back, carpet fashion, or grooved the same as the $\frac{7}{8}$″ material, instead of being square-edged as above.

One manufacturer gives an estimate of material for 100 sq ft as follows: $2\frac{1}{2}$ lbs $1\frac{1}{4}$″ finishing brads; $3\frac{1}{2}$ lbs wood filler; 3 pts shellac; $\frac{1}{2}$ lb floor wax. "If filled with varnish (instead of filler) 1 qt to 100 ft." For maple the filler is not required. The wt of $\frac{3}{8}$″ flg is 1,000 lbs to 1,000 ft; of $\frac{7}{8}$, 2,500.

Oak wainscoting, 36″ high above base, is also standard. It runs from 45 to 75c per lf, and is thus much cheaper than regular $\frac{7}{8}$ work.

CHAPTER XI.
GLASS

About a dozen years ago all glass in good buildings was put in by the painter; now the planing-mills have monopolized most of the business. They usually do it cheaper, for they buy their glass by the car-load, and they have boys who do their work so fast that the ordinary painter has to stand aside and watch. But about 20,000 lts of 10x14 for No. 7 and other buildings were put in by a local glazier at $1\frac{1}{2}$c each—and the millmen put in about as many more on the same plant.

It is the less necessary to give prices here as they are included in millwork. Only a few selected sizes are priced as a basis of estimating when not within reach of the lists which are furnished by the dealers. Here it is well to caution the estimator about the discounts. A discount of 50, 10 and 5, for example, does not equal 65, but only $57\frac{1}{4}$. First deduct 50%, then 10% of the result, and finally 5% of the last figure. Thus if the list-price is $100 a discount of 50% leaves $50; 10% of that is $5 to be deducted leaving $45; 5% of that is $2.25 which deducted leaves the real price $42.75. It is not only in glass where this holds, but in every kind of material with more than 1 discount. A large Chicago house recently had to warn its customers against this wrong idea which seems to be prevalent.

The glass discounts now are on common glass 90 and 5 unset; 85 set; on plate, 80 above 10 sq ft—75 and 10 for 10 sq ft and below. The quality estimated is usually A—not AA or B. (See "Sash" in Chap 10.) For fewer than 3 lts of plate boxing is charged at 6c per sq ft. The price of a large order is naturally cut—for ordinary purposes the following prices are unset at 90% discount from list for common; and plate as above:

Size	S. S.	D. S.	Size	D. S.	Plate		Plate	
10x14	6.5c	9.8c	24x48	$1.42	6x6	$ .07	48x 48	$10.40
12x18	10.9	16.1	30x36	1.17	10x 24	.48	48x144	34.60
12x48	43.8	55.8	36x36	1.42	10x 72	2.70	48x218	80.00

Size	S. S.	D. S.	Size	D. S.	Plate		Plate	
16x36	40.7	54.5	42x72	5.52	8x120	4.88	60x 96	32.60
16x60		$1.09	48x80	7.59	24x 24	1.35	72x138	49.60
20x72		1.88	60x70	7.59	24x 84	9.10	84x138	190.60
					28x168	22.20	120x218	454.20
					36x 72	11.70		
					36x170	30.40		

Leaded ds glass, no color: price from 30 to 60c per sq ft.
Mitered beveled-plate: $1 to $3 per sq ft according to pattern.
Leaded beveled-plate: from $1.50 to $3 per sq ft. If for door lights set in metal add 35c per sq ft.

Sand-blast: 25c.
Wheel-cut: 75c.
Chipped: single-process, 15c; dbl, 17c.
Maze: $\frac{1}{8}$, 13c; 3-16, 18c.
Enameled: clear, 15c; obscure, 17c.
Ground: 14c.

Venetian: $\frac{1}{8}$, 15c; 3-16, 17c.
Cathedral: 12c.
Opalescent: 20c.
Ribbed for skylights: 9 to 12c.
Wire: 20 to 23c.
Sidewalk: 20c and up.

SETTING:—The 10x14 lts on No. 7 were bedded and set for 1½c each, but no material was furnished. Allow about 1¾c per sq ft as an average for a reasonable number of lts. Allow 1-25 lb of putty per lf around edge of glass. The 20,000 lts of No. 7 took 2,800 lbs. With 80,000 lf, this is 1-28 lb. A smaller lot—only 345 lf—took 1-23 lb. Amount varies with depth of rabbet, bedding, etc. Thus on 1,900 lts 10x14, 565 lbs were used, or nearly twice as much. The putty might not be properly pressed; the rabbet was a trifle deeper. Large lts require more glaziers' points than small—allow 1 to every 6 to 9 in.

Plate glass costs about 10% of price for setting. Skylt glass, 8c per sq ft. Floor and sidewalk, 5c per sq ft.

WEIGHT:—Common glass, ss, 1.25 lbs to sq ft; ds, 1.6; plate, 3½ lbs, but weight of all glass varies. Some lts of plate on No. 9 were only half as heavy as others. To get wt of plate-glass box mult sq ft of surface by 10 and the result is in pounds. The complete work, including steel framework of skylt in place on No. 7, weighs 8 lbs.

The following weights are listed for roof glass—the thickness is given in fractions of an inch, and the wt in lbs: $\frac{1}{8}$, 2; $\frac{3}{16}$, 2½; $\frac{1}{4}$, 3½; $\frac{3}{8}$, 5; $\frac{1}{2}$, 7; $\frac{5}{8}$, 8½; $\frac{3}{4}$, 10; 1 in, 12.

CHAPTER XII
STRUCTURAL STEEL AND IRON

MEASUREMENT:—The rule for estimating this work is very simple: It is, "Get the exact weight and mult by the exact price." The trouble is in getting both.

CAST IRON:—If the pattern is made an approx figure may be had by mult the wt of new white pine by 13; of old wood by 14: the quotient will be in lbs. Or another and better way is to varnish the pattern, put in a tank of water, get the displacement in ci and mult by .26 for the wt in lbs. Unfortunately architects have not yet been educated to the point of furnishing patterns with their specifications, and we have to follow the old rules of measurement which are not so sure as the dipping process. The bases and capitals of cast-iron columns,

lugs, straps, horns, bands, swells, and all odd work have to be measured or guessed as carefully as possible. When we have only a few columns a slight error does not count so much, but with 100 it is different.

And this brings us to an important point that has to be considered: Are there 100 cols or only 2? If they are not of stock patterns it means a good deal of difference in the price. In the first case the cost of the special pattern is divided among 100; in the last, between 2. Here, as elsewhere, it pays to use stock patterns. (See Chap 21 on Standard Sizes.) Stock shafts are carried in foundries, and if possible special caps and bases made to suit design.

The only way for an estimator to get the value of a pattern is to take off the lumber—wp at $80 per M in our day—and then judge the amount of labor that is necessary to make it. Where there are many castings this is hardly necessary as the cost is divided.

The wt of cast iron is usually put at 450 lbs to the cf, or a trifle more than .26 per cu in. This is ¼ lb added to 1-100 lb, for those who are so lazy as not to understand decimals. At a distance from tables the rule is easily remembered: Get the ci and mult by .26 lb. A plate 44x68x¾″ weighs 583.44 lbs. By using .26 the loss is only a little more than ¾ lbs to 450, and this is close enough for estimating.

A column 12′ long, 10″ in diam outside, with 1″ metal, weighs 1,059 lbs without any base or cap. As the metal is 1″ thick the inside size is 8″; find the ci in a col of 10″ diam and in one of 8″; subtract the diff and mult by .26. An easily remembered rule for all circles is that they are to each other as the square of their diam. Thus 2 cisterns 8 and 9 ft diam hold water in the proportion of 64 and 81; a pipe 4 ft diam has 4 times as much sectional area as one 2 ft . To get the area of a circle mult the square of the diam by .7854. The square of a 10″ col is 100, which mult by .7854=78.54; mult by 144″—the length—gives 11,309.76 cub in. The sq of the diam of 8 is 64. Mult by .7854=50.2656, which mult by 144 gives 7238.246 ci, a difference of 4071.51 ci, which mult by .26 equals 1,059 lbs.

The foregoing illustration will serve for odd work: the following table will save the trouble of figuring regular sizes. Cap and base are not included. Outside diam and thickness of metal are given in inches: weight per ft in lbs:

Diam	Thickness	Weight	Diam	Thickness	Weight	Diam	Thickness	Weight
6	½	26.95	8	1¼	82.71	11	1	98.03
6	¾	38.59	9	¾	60.65	11	1¼	119.46
6	⅞	43.96	9	1	78.40	11	1½	139.68
6	1	49.01	9	1¼	94.94	11	1¾	158.68
6	1⅛	53.76	9	1½	110.26	11	2	176.44
7	¾	45.96	9	1¾	124.36	12	1	107.51
7	1	58.90	10	1	88.23	12	1¼	131.41
7	1⅛	64.77	10	1¼	107.23	12	1½	154.10
8	¾	53.29	10	1½	124.99	12	1¾	175.53
8	1	68.64	10	1¾	141.65	12	2	195.75

A slight knowledge of elementary geometry enables an estimator to get the surface of angles, etc; and failing the scientific method, there is usually another.

WROUGHT IRON:—The wt of all structural iron and steel is marked on plans, so that there is no difficulty in getting the total. The wt of cast-iron separators, bolts, rosettes, etc, has to be allowed extra for I beams. Some separators have 2 bolts; others only 1. Beams under 5″ have separators $\frac{3}{8}$ thick; 6 to 15, $\frac{1}{2}$; 20 to 24, $\frac{5}{8}$. Wt is, of course, regulated by depth and spread of beams. Get cu in. and mult by .26 lb if tables are not convenient.

The weight of wrought iron is 480 lbs to cf, or practically .28; while steel is 490 lbs. Jones & Laughlin give .263 for cast iron; .281 for wrt; .283 for cast steel.

Wrought iron and steel do not have to be reduced to ci so often as cast iron, because tables of sheet, flat, round, square, and all shapes are ready at hand. Some find it convenient to remember that a bar of iron 1″ square, 3′ long weighs 10 lbs. The wt of wrt iron mult by 1.082 gives brass; 1.444 copper; 1.47 lead.

It is a hard matter for a building contractor to remember that the wt of steel rails is given by the yard,—not the foot,—and that the gross ton of 2,240 lbs is used instead of the short ton of 2,000.

LABOR SETTING IRON AND STEEL:—The Omaha contractors usually allow $5 per ton of 2,000 lbs to set average work. Sometimes it can be set for $3.50. On plain work close to ground $2.75 has been found to be enough on 100 tons. It depends upon the size of the material, hight, etc. For store fronts $5 is a fair figure. The fronts of Nos. 5 and 6 were set for about this price. On No. 2 with 70 tons the cost was $4.50, but the material was set all over the fire-proof building and clear to roof. Wages were $1.50 for common laborers who set it all. Hand derricks were used in both illustrations. With a steam derrick such work can be done for about $3.50. Both cast iron and steel are included in figures.

But all of the foregoing work was set with common labor,—and the rules of the union do not permit any laborer to handle steel. Of course the average job does not require structural-iron workers, but where they are used, the cost runs higher, although they handle more in proportion to their number than laborers. The wage is now 40c per hour for men and 47$\frac{1}{2}$c for foremen. On all large steel work they are cheaper in the long run than laborers; but it seems that they ought to have their due proportion of them as other trades do. Work like that shown on No. 13 would cost more if set by laborers only than by tradesmen.

A fair figure for No. 13—which shows the framework of No. 7—is $8 per ton of 2,000 lbs to set and do field riveting. It was done for $7. This does not include drilling holes in the concrete to hold rag-bolts. Drilling 7 holes 1$\frac{1}{2}$″x29″ takes 2 laborers 1 day of 9 hours by hand, but the state of the concrete, soft or hard, has to be considered. Allow 10 holes at 23″ deep. Some contractors build in wood and withdraw it afterwards for bolts, and although this is not such an accurate method for centering it is so much cheaper that most prefer it. Or a bolt may

be set in pipe with room to move far enough to catch the holes. If a template is used there is not much danger of missing connections.

Approximately there are 10 field rivets to the ton. A safe figure is 10c each. An air riveter on straight work rivets about 400 to 500 in a day of 8 hours. This includes moving of scaffolds. The Omaha Auditorium, however, with 500 tons of steel, had 11,000 field rivets, or 22 to the ton.

Something has to be allowed for different classes of work. On No. 13 there are 36 girders 3′ 6″ wide x22′ long. The setting of them soon counts in tonnage. With these were other heavy girders, in all about 2,100 lf. But with train-sheds where light sections are used and where there are more changes of scaffolding the $8 price would run to at least $10. The lightest steel on No. 13 was the truss which was 5 tons. The Omaha Auditorium trusses are 10 tons each. But the steel on this building took at least $12, as angle work of gallery, hight of trusses, extra riveting, etc made work more difficult.

On No. 13 the steel was set and riveted for $6.50, but wages were lower than on No. 14, as laborers were used on former. Building is also lower. About ¼ of total was required for riveting. The time on both buildings includes setting derricks, scaffolding, and unloading from cars.

Before leaving the erection of steel it is better to look at the other view, for as with the laying of brick there is another. No. 13 cost, with contractor's profit, $7; No. 14, actual, $6.50; No. 8, the largest building, for about 800 tons, $7.90.; at the outside $10 should be enough. In "Carpentry and Building" for January, 1903, there is an article on the erection of structural steel on high buildings. It seems to be over-drawn, but strange things happen. The article complains of the high cost of building in New York as compared with other cities, and says that with the same number of hours per day and the same rate of wages steel erection costs from 2½ to 3 times as much as elsewhere. "It is no wonder that structural erection costs $15 to $18 a ton in this city as compared with $6.50 to $8 in other centers of building activity. A hand riveter who could easily average from 250 to 300 rivets a day contents himself in this city with 80. In other cities on straight work a good man finishes up 80 an hour. The pneumatic riveter—in almost any other city will drive 1,500 to 2,000 rivets in a day against 250 to 300 in New York."

Aristotle was not only a wise Greek—he was a wise guy—and one of his favorite maxims was, "All extremes are wrong." Between 80 in a day and 80 in an hour, or 640 in a day, there are quite a few laps. On the one side we have the loafer who is a pest, on the other the theorist who makes us yawn. An average day's work at shingling may be found elsewhere in this book—there are men who do several times as much, but I would not allow them to lay a shingle on a house I meant to keep.

I asked a man who has passed his life among steel put up in all sorts of places and fashions, "Could a pneumatic riveter finish 1,500 rivets in a day on a building?" "No, it could not," he answered; "and more

than that, it could not be done even on a shop floor where there is no climbing among scaffolding. I have one in the shop and I know what it can do. A good average is 500 on a building."

After getting local authority I was handed a report of Mr. A. B. Manning of the M. K. & T. R. R., to the Annual Convention of the Railway Superintendents of Bridges and Buildings, in which he discussed riveting:—"With pneumatic riveting hammers I find that 2 men and 1 heater can average in 10 hours 500 rivets, whereas by hand 250 rivets—more often less—was a good day's work for 3 men and 1 heater. One day we drove 700 rivets by using an additional man to take out firing up bolts, etc. This was the work of one air hammer only." He gives the cost of hand riveting at 3.68c per rivet, and air riveting at 1.62c.

On 93,480 rivets in the Chicago shipyards the machine rate ran from 1 to 2½c, depending upon size, etc; the hand rate, from 2½ to 4½. The machine average was 1.5c each; hand, 3.19.

In Cramp's shipyard on 1,300,000 rivets the hand price for 1″ was 7c; machine, 3c; for ⅞ by hand, 5.5c; by air, 3c. Cramp sets machine riveting 40% cheaper than hand; the Chicago yard, 47%. Small work can not be done at any thing like the same rate; and of course latitude counts for something: the London & Northwestern Railway, for example, reports 120 rivets per hour per riveter.

The importance of reliable labor time is seen when we consider the size of such buildings as Nos. 7, 8, and 14—all 150′ wide, and from 310 to 486′ long. The main building of the Rock Island plant at East Moline, Ill., is 276′-8″x860′. In "The Engineering News" of Feb. 11 '04, there is a description of the plant and a summary of the amount, of building material. Steel is 2,400 tons; and cast iron, 150. The U. P. and O. S. L. plants, as far as built, have together somewhat less than this tonnage. It is important to know if it can be set for $7 or whether $12 is required as the difference amounts to $12,000. Other items in the R. I. total are, 22,000 bbls Portland cement; 6,000,000 brick; 5,000,000 ft lumber; 64,000 sq ft factory ribbed glass; 4,200 sqs roofing. A labor difference of $1 per M in the brick makes a nice little sum.

The Atchison, Topeka & Santa Fe locomotive shop is 154′x852′; the "Reading", 204′x750′.

For erecting large electric cranes allow $3 per ton. If they are not put directly in place from the cars but have to be unloaded, $1.50 extra. Much, however, depends upon facilities;—4 cranes of 143 tons have been recently set for $300.

To lay sheet steel over large surface, 2c per sq ft; on doors, 4c. A common way of estimating the complete labor on tanks—round or square—is to allow 4c per rivet, but this is on the basis of compressed air. A tank 9′ diam x12 high is worth about $175; 15′ diam x12, $275.00.

PRICE:—At present the price of steel is high: a few years from now it may be low. On cars, Omaha, it is $65 to $70 per ton,—but a good deal depends upon quantity. Cast iron is now worth 2½ to 3½c per lb.

With ci the pattern has to be considered. In 1896 the price of cast iron was $19; of steel, $27 FOB Omaha.

MISCELLANEOUS:—Hyatt or Prismatic lights are worth about $1.50 per sq ft; Luxfer prisms complete, $4 to $5 on large order. Sidewalk or concrete lts in frame with glass, $1.75. Coal hole covers, prismatic, from $5 to $10 each, 20″ to 24″; solid, $1.50 to $4. With a coal hole cover the depth and wt are regulated by sidewalk; sometimes it may be only 4″, and again with a heavy brick arch it may be 13.

WICKETS:—For ticket windows, from $5.60 to $25, of 30 designs examined.

WROUGHT-IRON GRATINGS:—75c per sq ft; cast iron, 3c per lb.

GAS-PIPE DOUBLE-RAIL:—In place, 75c per l ft; single, 50c. Posts, $2.50 to $5 each. "Spike" or "Loafers Rail," 12 to 15c per ft.

SMALL WRT-IRON GATES:—10c per lb. Wrt-iron fence, 4 to 6c. A long railing, about 4 ft high, ¾ square uprights, 6″ centers, was recently set in place for $1.50 per running ft.

WRT-IRON SHUTTERS:—Hinged, 45c. Sliding, 55c per sq ft in place, Omaha. Allow freight at 8 lbs per sq ft if required.

VAULT-LININGS:—From $65 up: 620 to 830 lbs for average.

Special prices are given on patented hangers, etc, but in general for all anchors, stirrups, heavy hinges, and such work, get wt and mult x 5c per lb. For rods, 3c.

DUPLEX JOIST-HANGERS:—For 2x6 to 2x10, 14c each.

2x12 to 2x16	20c	6x14 to 6x16	65c
3 and 4x6 to 3 and 4x10	28c	8x8 to 8x12	65c

DUPLEX WALL-HANGERS:—Are about 50% more.

IRON LADDERS:—2″x½ sides, ⅝ sq rungs, set for 90c to $1 per ft high.

FIRE-ESCAPES:—1¼ gas-pipe rail for sides, $1 per ft high set; platforms of ordinary width and length, $2.50 per lf; 21″ stairs for fire-escapes, $4 per ft long on rake; platforms, $4; or about $125 per story. A large iron stair 3′ wide for fire-escape on No. 2 cost $502 for 3 stories. For 2′-6″ fire-stairs with long platforms, outside pipe supports and railings on both sides, allow $18 to $20 per ft set in place and painted, the price being taken on the plumb and not on the rake.

When taking bids on No. 2 I was offered a spiral chute that had been installed and approved at Louisville, Ky., and is now as far north as Boston where school children are shot through it while you wait. If a thing is new we smile and are rather clever. Perhaps this may be the coming way of shooting the chutes.

Of course there are many varieties of fire-escapes at different prices.

The labor on average wrought-iron work is 1½c per lb; a safe price for bar iron is 2c per lb FOB Omaha.

CHAPTER XIII

TIN, GALVANIZED IRON, COPPER, ETC.

PRICE:—For I. C. old-style tin, $10 per sq laid; for I. X., old-style tin, $12; I. C. common tin, $7 to $8; I. X. com, $8.50 to $9.50.

Flashing, gutters, downspouts, are now usually made of galv iron instead of tin, but in most cases the following prices will serve for both:

FLASHING:—For No. 26 galv iron 14″ wide, 14c per lf; 20″, 20c; 28″, 25c; No. 24 same widths, 15c; 22, 27c. For counter-flashing—9″ and 9″—25c. For wide and long flashing of No. 26, 10c per sq ft; for No. 24, 12c. Copper flashing in large quantities costs per sq ft about 30c, and 35c for counterflashing; but copper often changes in price. No. 22 galv iron costs about 13c; 24, 8c; 26, which is the kind usually specified, is about 5c per sq ft. Zinc, which is occasionally used, runs to 10c per sq ft.

GUTTERS:—Allow 1c per inch of girt per ft for gutters hung in place. For lined gutters, 10 to 12c per sq ft of material used.

DOWNSPOUTS:—For 2″, 10c per ft; 3, 15c; 4, 20c; 5, 25c; 6, 30c; all corrugated. These prices include setting.

FINIALS:—They may be had at $2 or $20, and even beyond. A plain one about 3 or 4 ft high costs $4.

CRESTING:—From 20 to 40c per lf. This includes setting.

VENTILATORS:—4″, $1; 6, $2; 9, $3; 12, $4; 16, $10; 24, $20; 54, $100. The price of ventilators depends upon the kind selected.

SKYLIGHTS:—With ¼ glass complete, 50c per sq ft on rake, set. For large skylights like those on No. 7, in different styles of different makers, 50c is a safe figure here for a small order. In the east the freight is less; in the west, more. The weight is 8 lbs to the sq ft; setting 8c.

Speaking-tubes are put in for about 10c per ft, including mouth-pieces. The raw material is worth about 3c.

The contractors' profit is included in foregoing prices.

MEASUREMENT:—The size of tin sheets is 14x20 and 20x28. The large size is commonly used. A box contains 112 sheets. The wt of I. C. is about 8 oz per sq ft; I. X., 10; but the sheets vary a little. A box of I. C. weighs 225 lbs; of I. X., 285. No allowance is made by manufacturers for any lap of tin, galv iron, corrugated iron or copper. Lap on a 26½ sheet takes 2½, leaving 24. There are many light-weight tins. The galv-iron sheet varies from 24 to 30″ wide x 96 long.

For a tin roof allow per sq 29 sheets of 20x28; for solder, 5 lbs; charcoal, 10c per sq; rosin, 1 lb to sq; roofing nails, 1 to 1½ lbs to sq. This number of sheets allows for a lap of 1 inch at joint. For 14x20 sheets, 62 to 63 to sq; allow about 50% more solder, etc. Tin roofing should be measured by the sq. As with plaster, etc, the trade rules do not deduct openings below a certain size, and they also provide for other exceptions which might trap the unwary if work were taken on a sq ft basis; but here these rules are not set down nor considered.

To the sq of galv iron allow 5 lbs of solder and other items as for tin.

Standing-seam tin takes 3″ off 20 wide, instead of only 1 for lap and this loses 2; but as no solder is required the cost is about the same.

A box of I.C. old-style, costs about $8.50; 20x28, $17; of I. X., $2.50 extra.

LABOR:—For plain roofing allow 4 sq in a day for 2 men. If painted on under side, allow 1 hour extra for 1 man per sq. Two men will put up 200 ft of ordinary hanging gutter in a day; and will line 150 sq ft of box gutter.

Two men will lay about 400 sq ft of valleys in a day; and finish 400

lf of ordinary flashing, or 150 sq ft of flashing and counterflashing; will put 200 to 400 ft of downspout in place; and 100 to 200 ft of ordinary ridge. But some judgment has to be used as to allowances, for one building might be near the ground and easily handled, while another might be high and broken into many angles.

CORNICES

PRICE:—For a general rule take the girt of a galvan-iron cornice and allow 1c per inch per ft long. Thus if the front measured 36″ following the curve of all moldings, and the distance back to the wall was 14″ with an allowance of 6″ into wall for top and bottom, the price would be 56c per lf. This includes the straight work only. Add end-trusses, dentils, brackets, and all extra work. There is an endless variety of ornamental work which has to be priced according to detail. The foregoing price includes setting. No. 26 iron is standard. The price of several sizes is here given *without setting.* The plumb hight is taken, not the width of metal.

Hight	Projection	Price per ft	Hight	Projection	Price per ft
26	12	$0.40	24	10	$0.30
24	12	.40	24	12	.35
26	12	.75	28	14	.80
28	15	.40	30	15	1.00
36	15	.85	36	20	.75
48	24	1.85	32	14	.60
44	20	1.50	48	24	2.20
40	24	1.35	48	26	1.85
36	24	1.30	45	24	1.50
60	30	3.25	60	26	2.35
84	36	3.50			

These prices include brackets, dentils, etc, but no end-trusses. Ends run from $2 to $7. Miters are extra, ranging from $1 to $3; a miter is usually put at same price as 12″ of straight cornice. Pediments are extra, and may run from $5 to $20. Ordinary letters are extra at 25c to 50c each. If the girt system is taken and dentils, etc added, the price has to be set for each item. A dentil may cost from 15 to 30c; egg and dart molding, 15 to 30c per ft. A bracket according to size and detail, from 30c to $1; balusters 4x4x24, 85c; medallions, 50c per ft. Urns cost from $3 to $10. Crown and belt moldings run from 8 to 15c without setting, but it is possible to make them cost several times as much. In all cornice makers' work detail is of vital importance.

WINDOW- AND DOOR-CAPS:—Of ordinary lengths, $2.50 to $4; with pediments, etc, $4 to $6.

GABLE ORNAMENTS:—,$1 to $5. Copper eagles, 5-ft spread, $75; 3-ft, $55; zinc eagles, 30% less.

HIP-ROLLS:—10 to 12c per lf.

LABOR:—Setting of cornices 15c to $1 per lf.

METAL CEILINGS

PRICE:—Taking a general average allow 8 to 12c per sq ft put in place but not painted, except with 1 light factory coat. There are more

expensive patterns, but 9 out of 10 ceilings can be put on within these prices.

The raw material for the plates or body costs from $4 to $4.50 per sq laid down in Omaha. Panels run from 25 to 40c per sq more. Centers are from 25 to 40c each. Corners ,borders, and fillers run to about the same price as the plates, but sometimes a special corner costs twice as much as the average of the ceiling. Small moldings are from 2 to 6c per lf. Tees, crosses and ells to match, 5c to 10c each. Cornices, coves, and friezes, from 3 to 15c per lf according to size and pattern. Miters, 5 to 20c each.

A word of caution has to be added: Plates are priced at $4 to $4.50; they can be bought of stock patterns for $7. Centers instead of being 25 to 40c each may be $5, and so on through the list.

MEASUREMENT:—The foregoing prices include an average cornice around the wall, so that for this estimate the surface between the walls is close enough. For an order the level part has to be taken, and cornices, coves, beams, corners, centers, etc, attended to by lf measurement or separately. Furring is also included in the price,—from 80c to $1 per sq is enough. Strips are not furnished by manufacturers, but cornice brackets and ceiling nails are. Plates and panels are usually about 24x24, but on cheap grades plates are also sent 96″ long.

LABOR:—Allow from $1 to $1.50 per sq. A ceiling recently put up ran to $1.50 according to the time kept, and there was nothing very fine about it. The room was not large, and where there is a large space there is more progress made. On good ceilings a man and helper will not put on more than 3 or 4 sqs with cornice, centers, etc included. On large rooms with the plainest kind of work they may do from 6 to 8 sqs. On a roof a man and helper will lay from 12 to 15 sqs of corrugated iron, but even the cheapest ceilings do not go on as fast as this. Wages of tradesmen are 40c per hour.

WAINSCOTING:—This stamped material is made from 24 to 28″ high, and is worth about the same as ceilings. It is made to follow rake of stair if necessary. Cap and base are not included and have to be allowed extra at the price of small moldings. Generally a wood base is preferable. For setting allow 8 sqs of ordinary work per day for 2 men.

ORNAMENTAL SHINGLES

PRICE:—The raw material runs from $4 to $9 per sq. There are so many varieties that a price can not be set to suit all. Another style of manufacture gives the shingles in a pressed sheet 8′ long—and another size is 20x28, so that there is no standard of price.

MEASUREMENT:—Some manufacturers send enough to lay a square, just as the slate quarrymen do; others instruct the contractor to allow from 4 to 6 sq ft extra to the 100 for laps. Different sizes of shingles are made, so that the following figures will not always apply:

14x20, 68 shingles to sq.
10x14, 148 shingles to sq.
7x10, 319 shingles to sq.

Common tin shingles, used over wood, 5x7, $1.50 per 100
" " " " " " 5x9, 2.00 per 100.

LABOR:—For separate shingles give same allowance as for wood in Chap 9; for sheets, 8 to 12 sqs per day for 2 men.

Pressed-steel brick siding and rock-faced siding, $3.25 for material; standing-seam roofing and crimp roofing, $2.90 to $3.50. Such material comes in different sizes and prices. The labor runs on an average from 9 to 12 sqs per day for 2 men.

Corrugated iron is worth from $5 to $6 per sq in place on wall.

COPPER

The electrical demands of our time are so great that the copper market is never at rest. The high price of the one year is outshone by that of the next. Copper work is expensive, but it lasts.

The cornices of Nos. 3, 5, and 6 are of copper, and the towers are covered with the same material: all the skylights of No. 7 are flashed with it.

Store fronts are now made of oxidized copper. This adds about 40c to the sq ft of the raw material.

Allow for copper flashing from 28 to 30c per sq ft. The material runs about as follows:

16 oz soft, 21c per sq ft. 14 oz soft, 22c per sq ft.
16 oz cold-rolled, 22c per sq ft. 14 oz cold-rolled, 23c per sq ft.

For 20 oz copper on sinks, etc 40c is a fair price.

CHAPTER XIV.
ROOFING

Benjamin Franklin said that a good roof is as important as a good foundation.

Lead roofs which I have often helped to put on, are never used here and need not be considered. Shingle roofs are taken care of in Chap 9.

GRAVEL:—So far as quality goes there are many kinds of gravel roofs. For a permanent building it pays to put on the best. The standard price for a first-class roof used to be $5, but $4 is now looked upon as a good price, and some large 5-ply roofs—(4 solid mopped sheets, 1 dry sheet) are put on for even less than $4. The danger line comes at $3.50, for such work is apt to be slighted at that price. These figures do not include the flashing of walls, which the tinner attends to. Of course gravel can be put on flat roofs only. Roofers prefer a pitch of not more than ½″ to the ft; it should never exceed 1″, although gravel lies on 2″ if well laid. Several years ago a roofer gave me ¼″ as his ideal pitch.

The price of screened gravel FOB Omaha is from $2 to $2.25 per cy. There are pits at Hastings and Springfield, Neb. Gravel per sq without labor therefore costs about 35c. Labor runs from 50c on low buildings with fairly large surfaces, to 70c, 75 and 80c, when higher. On some buildings $1 is necessary, but this price is unusual and due to special requirements. A gang of 7 men lay on an average 40 to 50 sqs in an 8-hour day. Wages for roofers, 35c; laborers, 20 to 25c.

The ordinary weight of gravel on a sq is 400 lbs; on a better class of work 450. The finished roof with composition and paper runs from

550 to 650 lbs. A cy of gravel covers about 6 sq and weighs 2,700 lbs. A good roof would run about as follows: 450, gravel; 80, composition; 75 felt, or a total of 605 lbs for 4-ply and dry sheet. But 20 lbs of composition to the ply is used on better roofs, and if sheets are mopped all over instead of at joints only the wt runs to 125 lbs. Ordinary composition is $\frac{1}{3}$ tar and $\frac{2}{3}$ pitch. Sometimes $\frac{1}{4}$ tar is all that can be used. Tar costs about $5 per bbl and pitch $22 per ton. A rough coat of pitch on brick is worth about 85c per sq. Ordinary caulking of joints about $2\frac{1}{2}$c per lf.

TAR FELT:—A dry sheet is often put down first, especially above finished ceilings to keep tar from running through. It weighs 7 lbs to sq. A roof should not have less than 4-ply solid or 3-ply and dry sheet, and it is better to have 4.

Roofing paper runs from 12 to 15 lbs to sq; building paper weighs about 15 lbs,—but it is necessary to remember that red rosin and straw-board are sometimes used for building paper. These 2 brands are not used on roofs, but are put here for convenience among other papers. Packers' insulated paper for refrigerator work, $1 per sq. A roll of strawboard contains from 250 to 300 sq ft, weighs approximately 50 lbs, and costs about $1.25. Red rosin costs $37 per ton; roofing paper, same price. Various kinds of red rosin run from 20 to 40 lbs. The National brand of R. R., 40 lbs to 500 ft; Arctic, 35; Buckskin, 30; Columbia, 25 to 500. Nothing below 25 is worth using. The last brands are used as dry sheets.

PATENT ROOFS:—There are so many kinds of patent roofing materials that one does not know where to begin. They are as common as patent medicines, and except for temporary purposes, most of them are as worthless. There are some good ones among them, but the good have to bear the sins of the bad. The price of a few is given. They are cheaper than slate or even shingles, and they can be put on roofs with a pitch that forbids gravel. On steep roofs they are safer than on flat.

Elaterite	$4 for 6 X per sq
Actinolite	$5 per sq
Carey	$3.75 to $4
Rubberoid	$3.25

CAREY:—Comes in rolls 29″ wide. Sufficient is put in a roll to cover 1 sq. With each roll is sent 2 gals magnesia roof paint, $\frac{1}{2}$ gal lap cement, 2 lbs nails. The manufacturers follow the old rule of measurement. Do not deduct openings unless they are more than 50 sq ft; if more than 50 and not more than 100, deduct half; if more than 100, deduct full size. Sheets are lapped $1\frac{1}{2}$″ and nailed every 2″. "One man can apply 10 sq of cement roofing in the same time it will take him to apply 2 sq of shingles. The standard weight is about 90 lbs to the sq; extra heavy, 115. This includes all materials."

Raw material costs $3 per sq FOB Omaha. A car-load contains 300 sqs. Labor is about 50c per sq.

ELATERITE:—Comes in rolls 29″ wide x 44 ft long, for 3X and 4X; for 5X and 6X, 32″ and 40 ft. Each roll contains 107 ft, or sufficient

to lay a square after allowing a 2″ lap. The weights differ: 3X, 30 lbs per sq; 4X, 40; 5X and 6X, 65. Each square requires 5 lbs of cement, 11 oz of $\frac{7}{8}$″ tin caps, and 9 oz of 1″ barbed roofing nails, which are sent with order.

"On small buildings with 15 or 20 sq 1 man will lay about 8 sq in a day; on ordinary buildings from 25 to 50 sq, flashing included, 10 sq per day; on large jobs of 100 sq or more, 20 sq." These quantities are too high if nailing is properly done. On such material as elaterite, rubberoid, etc, labor is worth about 35c per sq. This price was taken from actual work over large surfaces. If the higher figures are reached, so much the better, but the law of averages needs to be remembered.

For shipping weight, add 6 lbs per sq for the fastenings. Elaterite, FOB Denver, Colo., costs $3.50 for 6X; $3 for 5X; $2.50 for 4X.

RUBBEROID:—This roofing comes in rolls 36″ wide. Each roll contains 216 sq ft, or enough to cover 2 sq. The regular lap of 2″ is allowed, and the nails are at 2″ centers. The weights are as follows: $\frac{1}{2}$-ply, 27 lbs to sq; 1-ply, 35; 2-ply, 45; 3-ply, 56. Each sq requires $\frac{1}{8}$ gal of rubberine; $\frac{3}{4}$ lb caps; 1 lb nails, all of which material is sent with rubberoid. The following prices are FOB Omaha:

	In lots of less than 20 sqs	In lots of 20 to 49 sqs	In lots of 50 to 99 sqs	Lots of 100 sqs and up
1½-ply........	$1.79 per sq	$1.71	$1.63	$1.54
1 -ply........	2.29 per sq	2.18	2.07	1.96
2 -ply........	3.29 per sq	3.13	2.97	2.81
3 -ply........	4.04 per sq	3.84	3.64	3.44

Above prices are for complete roofing.

Extra rubberine roof coating	$1.35 per gal
Extra nails.	.05 per lb
Extra tin caps.................................	.10 per lb

With patent roofs it is in general sufficient to order the number of sqs and the necessary cement, nails, caps, etc, are sent,—but contractors should have a clear understanding with supply men that enough cement is to be sent to finish the work, as the listed quantities are usually too low. Theory and practice are different.

SLATE PRICES:—The following prices FOB Omaha may be taken for a guide, although they sometimes change. They vary according to size of slate:

Genuine No. 1 Bangor with certificate..............	$4.50 to $6
No. 1 Bangor Ribbon, with certificate	4
No. 2 Bangor Ribbon, without certificate	3.25
No. 1 Pen-Argyle, Albion, Jackson	4.25 to 5
No. 1 Lehigh and Pa. Black.	4.15 to 4.90
No. 1 Chapman.	4.25 to 5
No. 2 Chapman.	3.25
Chapman-Boys	4
No. 1 Peach-Bottom................................	5.25 to 6.75

No. 1 Peach-Bottom, 3-16 thick, 25c per sq extra.
No. 1 Peach-Bottom, $\frac{1}{4}$ thick, $7.50 per sq, all sizes.

No. 1 Unfading-Green	5 to 5.75

For 3-16 add 75c per sq; for $\frac{1}{4}$. add 3 per sq; $\frac{3}{8}$, add \$10.

No. 1 Purple	5 to 5.75
Variegated-purple	3.15 to 3.90
No. 1 Sea-green	3 to 3.90
No. 1 Red	8.50 to 10.50

For same 3-16, add \$1; $\frac{1}{4}$, \$5; $\frac{3}{8}$, \$11.

No. 1 Brownville or Monson, Maine	4.80 to 7.20
No. 2 Brownville or Monson, Maine	5 to 5.50

For the 3 best sizes, 8x16, 10x16, 9x18, the following prices will be useful:

No. 1 Gen. Bangor	5 to 5.25
No. 1 Pen-Argyle, Albion, Jackson	4.75 to 5
No. 1 Lehigh or Pa. Black	4.65 to 4.90
No. 1 Chapman	5 to 5.25
No. 1 Peach-Bottom	6.75
No. 1 Unfading Green	5.75
No. 1 Purple	5.75
Variegated	3.60 to 3.90
No. 1 Sea-Green	3.60 to 3.90
No. 1 Red	10.50
Brownville or Monson	7.10 to 7.20

The freight from Penn. to Omaha is \$2.64 per sq; from Vermont, \$2.55 to \$2.75; this and hauling from cars to building must be added to material and labor for cost price.

The price of roofing cement is 4c per lb. The quantity required up hips, rakes, and finishing course at ridge, as per U. S. specifications, is about 1 lb per sq of whole surface. Large valley slate are better not cemented; but small pieces ought to be. "Use Elastic Roof Cement up rake, under top courses, and wherever small pieces are used, and you will have no trouble with slates coming out."

The price per sq, laid, is given under "Roof Covering," page 15. Large slate are cheaper both for material and labor than small; an 8x16, for example, is worth laid about \$1.50 more than a 12x22. Bangor, Green and Red slate weigh about 650 lbs to the sq; Peach-Bottom, 750; Monson, 800.

LABOR:—The wages of slaters are 35 to 40c per hour. Their transportation and board have to be paid for work in country.

A 50-lb roll of No. 3 paper will cover 400 sq ft. The cost of laying it runs from 15 to 20c per sq. The lap should be about 3". When each slate is laid in elastic cement the labor costs from 40 to 50% more,—but although this is sometimes recommended, even government work calls for only hips, ridges, and other exposed parts in cement. In such case the usual labor figure is sufficient.

On the roof of No. 9 containing 82 sq 2 men put on the 10x16 slate in 91 hours each. The punching took 26 hours additional for each. The punching took 2 laborers to attend the slaters; the 182 hours of slaters' labor took 102 of laborers'; total for slaters,208; for laborers,128 hours. This is at the rate of $6\frac{1}{3}$ sq per 8-hour day for 2 men with laborers in attendance on a plain roof. Patching afterwards took 12 hours.

On some roofs, with many hips and valleys, a day's work of this size of slate is 4 sq. Five is passable on a roof with an average amount of angles and shorter stretches than No. 9. This includes the laying of the paper. Sometimes the complete roof is covered with paper nailed down with laths to keep out rain before slate are laid. More time is required to do this than if it is put down with slate. Allow $1\frac{1}{4}$ to $1\frac{1}{2}$ hours per sq. On plain straight work with gables a fair average is 8 sqs, and sometimes 10.

On No. 11, which is a type of the worst kind of roofs, 2 men in 8 hours laid paper and averaged 3.6 sqs of 8x16 slate on a surface of 65 sqs. But laborers' time—100 hours—has to be added to slaters' for the complete cost. A good illustration of the difference between a plain and a complicated roof is given in Nos. 9 and 11.

On some towers 1 sq is enough for 1 man.

The rear and side walls of No. 10 were slated—allow $1 per sq extra for labor on plumb.

One manufacturers' listed price for punching at the quarry runs as follows: 22 and 24″ slate, 10c per sq; 18 and 20, 15c; 16″ slate and under, 20c; slate are drilled and countersunk at double the foregoing prices. Government work is always D and C. When slate are full 3-16 thick the price is 50c; when full $\frac{1}{4}$, $1. Another list gives 30c as the lowest price, and for small and average slate this price is regularly charged. Quarry punching is cheaper than punching by hand; the 82 sq of No. 9 cost about 45c, and that was with 16″ slate. But slaters often punch by hand for the following reasons:—

(1) Ordinary slate come in 3 thicknesses, and if the roof is properly laid, each thickness is put by itself so that the slate in the next course will lie flat and not leave a space for wind and rain. They have thus to be selected in any case, and the punching is done at the same time.

(2) If slate come punched there is no chance of reversing them if the corner is broken off. The nail-hole can not well be exposed.

QUANTITY:—Roofs are measured for slate in the same way as for shingles, but the projection of the slate over the eave ought to be allowed extra, and also the doubling of courses there which adds 1 exposure. But this under-eave course, with the 3″ standard lap, need be only $1\frac{1}{2}$″ longer than half the length of the slate used. If work is done by the square some trade rules will be applied as with brick, plaster, painting, etc. Hips and valleys, for example, are allowed 6″ on each side extra for waste; in contract work slaters usually omit this ft and depend upon stretching the course $\frac{1}{8}$″ to make up the loss, just as is often done with shingles. With both slate and shingles courses have to be spaced to show the last course at ridge of about the same width as the rest of the roof, and a strict adherence to the letter of the specification would spoil the spirit of the work.

The actual surface and eave-course give the quantity to be ordered, but 1% extra is needed for waste unless the roof is very plain.

Slate are ordered in squares, and a square lays 100 sq ft at the standard lap of 3″. The smallest car-load is 50 sqs, and the largest 90. In less than car-load lots the cost for freight is about double. It takes about

12 hours to unload a small car on the ground. On some slate certificates are given, so that the owner may be sure of what he is getting.

Bangor slate must be loaded separately to secure certificate. Sea-Green, Unfading-Green, Red or Purple, can be loaded in the same car. There are many grades of Bangor.

DESCRIPTION

"Peach-Bottom:—A hard black slate of glossy appearance, strong, and of uniform color.

"Brownville, Maine:—A black slate of uniform color, smooth, glossy surface, and strong.

"Monson, Maine:—A slate of a dead black color, and strong.

"Black-Bangor, Pa:—A strong, good slate.

"Unfading-Green:—A gray-green slate of unfading color.

"Sea-Green:—Does not fade equally.

"Variegated:—A slate composed of purple and green. Strong quality but will not hold its color.

"Red:—Excellent slate, but high-priced.

"Purple:—A slate of that color. The present production is small.

"Slatington or Lehigh:—A blue slate produced along the Lehigh River in the vicinity of Slatington, Pa. Generally, a low-priced slate.

All slates fade,—but good slates fade evenly.

TABLE SHOWING THE SIZE OF SLATE

Size of Slate. Inches	Number in each Square	Exposed when Laid, and Distance of Lath	Nails to Sq. 3d Galvanized		Size of Slate. Inches	Number in each Square	Exposed when Laid, and Distance of Lath	Nails to Sq. 3d Galvanized	
			Lbs	Ozs				Lbs	Oz
24x14	98	10½ in.	1		16x10	222	6½ in.	2	3
24x12	115	10½ "	1	2	16x 9	247	6½ "	2	7
22x12	127	9½ "	1	4	16x 8	277	6½ "	2	12
22x11	138	9½ "	1	6	14x10	262	5½ "	2	9
20x12	142	8½ "	1	6	14x 8	328	5½ "	3	3
20x10	170	8½ "	1	11	14x 7	374	5½ "	3	11
18x12	160	7½ "	1	9	12x 8	400	4½ "	3	15
18x10	192	7½ "	1	14	12x 7	457	4½ "	4	8
18x 9	214	7½ "	2	1	12x 6	534	4½ "	5	4
16x12	185	6½ "	1	13					

For heavy slate allow 20% more of *4d* nails.

"To determine the number of pieces to a square of any size slate not given, first deduct 3 inches from the length; divide this by 2; multiply by the width of slate and divide the result into 14,400.

An example—20x10 would be calculated thus: 20—3=17 divided by 2=8½, 8½x10=85. 85 divided into 14,400=169 41-100 pieces."

The standard lap is 3″, but 2 is enough on towers, steep roofs, etc. This of course changes the number of slate required. More than 3″ lap is seldom used, but where it is the slate must be watched at butt, as they may not lie close to lower course. The best sizes are 8x16, 10x16, 9x18, on ordinary roofs; smaller sizes are used on towers.

If copper nails are used allow 60c per sq extra. They run from 20 to

25c per lb. Small slate, of course, require more nails than large. For some tile $1 is not too much.

Hauling of slate and tile sometimes amounts to a sum worth watching. The distance from a railroad has to be considered; 50c per ton in the city might run to $2 in the back precincts.

Flashing is not included in the figures for slate and tile.

SNOW-GUARDS

The following prices are for Baird's patent. Pipe is not included. Use $\frac{3}{4}''$ galv. (See price in Chap 17.) Three pipes are used in hight. Standards for guards are placed about 5′ apart. Allow 1c per ft for putting pipe in place.

Price List

The iron plate is made the size of roofing slate and of suitable thickness to lie properly with regulation thickness ($\frac{3}{16}''$).

Size of Slate	Price of each Guard complete	Size of Slate	Price of each Guard complete
14x 7	$1.55	20x10	$2.10
14x 8	1.60	20x12	2.40
16x 8	1.70	22x11	2.40
16x 9	1.80	22x12	2.50
16x10	1.85	24x12	2.65
18x 9	1.85	24x14	3.10
18x10	2.00		

BLACKBOARDS

The standard widths of slate blackboards are 3 ft, 3 ft 6 in, 4 ft, 5 ft. The thickness is $\frac{1}{4}$ to $\frac{1}{2}$ in. The price runs from 15c per sq ft on the narrowest to 18c on the widest. Add freight, 40c per cwt. Setting is worth 3c per sq ft.

TILE

PRICE:—The interlocking tile on the large roof of the Union Station, Omaha, ran to about $16 per sq laid. On smaller buildings allow about $19 to $20. Shingle tile ,which does not interlock, $16 on large surfaces; $18 on small buildings. Spanish tile run about $24. Something, of course, depends upon the style of the roof. With many angles and dormers, the cost runs higher, and towers reach as high as the dollar column as they do in the air. For towers and dormer-windows allow approximately $30. Some will cost more, but the average of the roof will bury the sorrow. These figures do not include strips to hold tile on roof. (See Part 1, page 15 for a fair price.)

''Prices of tile vary from $6 to $30 at factory, and of ridge- and hip-rolls, from 15 to 50c per ft.'' Spanish tile cost about $50 per 1,000. Shingle tile about $10 per sq FOB factory, St. Louis. Some interlocking tile can be bought at factory for $9 per sq; hips, 25c per ft, ridging, 50c; finials for the standard of 2 hips, $3.50 each—add 50c for each additional hip, as on octagons, dormers, etc, with more than 2-way terminals.

MATERIAL:—For Ludowici tile, 1x2 strips are usually laid $13\frac{3}{8}''$ centers. For Spanish tile 1x2 are also used. Shingle tile do not require

strips, except a lath at eave the same as for slate. Some tiles are laid without strips, some are spaced at $10\frac{1}{4}$; the style selected must be examined before the bill of material is made out. If roof is without sheathing, heavier strips are necessary.

Shingle tiles are made 6x12, $6\frac{1}{4}$x$12\frac{1}{2}$, etc, the exact size depending upon the maker. A $\frac{3}{8}$ tile weighs from 900 to 1,000 lbs per sq; $\frac{1}{2}$, 1,350. The first course is doubled like shingles and slate. Shorter tile are used for starters—about $6\frac{1}{4}$x9. The finishers, or ridge-tile, are about the same size. Half tile are required at gables, chimneys, etc, to break courses. These are about 3x12, and must be rights and lefts if not of plain pattern. In general it is far better to send roof-plan to factory and have order made out there.

About 440 shingle tile are required to the sq at an exposure of $5\frac{1}{4}$ with tile $12\frac{1}{2}''$ long; at 5″ with 12″ tile, 480. Each tile requires 2 4*d*, or $1\frac{1}{2}$ galv-wire nails, but sometimes copper nails are used. Roofing felt should be put on. Elastic slaters' cement is required for valleys. Connor's, Heltzell's or Pecora brands are recommended. Finials, crestings and hip-rolls should be laid in Puzzolan Portland cement colored to match the tile. This cement does not saltpeter—most roofers have never heard of it, and use the common brand.

Shingle tile are made in a variety of colors and patterns. There is an endless variety of ridge-rolls, hip-rolls, starters, finials, etc. The prices are as various as the patterns. A minimum car-load runs from 24,000 to 30,000 lbs. Freight rates are more than double on less than car-loads.

Interlocking tiles are of so many different sizes that the catalog must be consulted for number and weight. The average weight is about 750 lbs. but some run to 850. The number varies from 135 to 290. Tower tiles require from 400 to 600. Spanish tiles run to about 220, although catalog gives only 200.

Roofing felt weighing 40 lbs to sq is necessary. It should be nailed to roof with permanent laths spaced 24″. Above lath 1x2 wood strips are nailed to suit spacing. Double at eave; run up valley, and also perpendicular walls.

LABOR:—Some interlocking tiles are not nailed down like slate or shingle tiles: "Every tile in the eave-course, and every other tile in each course above, to be fastened to the sheathing with No. 20 copper wire through a staple nailed to sheathing and through a hole in the tile." This is not always done. If it is, a day's work for 2 men should not be set at more than 5 sq.

On a roof of Spanish or interlocking tile 2 men can lay from 8 to 10 sqs in an 8-hour day. With a complicated roof like No. 11, half of this is enough. This allowance is taken from a recent large contract. On shingle tile allow 6 to 8 sqs for 2 men with laborers, as for slate. If like No. 11, 4 sqs. For towers, dormers, etc, 2 sqs. The smaller the tile, as a rule, the longer time, as each piece has to be handled separately; and the greater the number of nails. (For tin, galv-iron, and copper roofing, see Chap 13).

CHAPTER XV
PAINTING

MEASUREMENT:—Somewhere, years ago, I saw a rule to the following effect: "Painting is measured wherever the brush touches." That is the rule we follow. Glass is now deducted by the leading painters and the price raised accordingly. Actual surface only is taken so that quantities can be made out from first estimate.

So far as taking off quantities is concerned, a carpenter can usually do this much easier and quicker than a regular painter, because he already has the number of sq ft of ceiling, wainscoting, and floors; the number of openings, the lf of base, and a dozen other factors of the complete bill at his service, while the painter would have to go over the plan anew, and probably get mixed on the carpenter's specification.

Windows and doors are easily measured:—Deduct the glass from the wood surface, and do not be too exact. The average door has about 6 yds for both sides; window, 2 to a side, as the one may be oiled and the other painted. If glass is not deducted painters allow from 3 to 4 yds to each side of window. Our method allows half and doubles the price.

For porch cornices, rails, balusters, lattices, and such ornamental work it is hard to give a rule that will fit all cases. Get the surface roughly and raise the price to suit the work. The material does not cost much, but the time is anywhere from 2 to 10 times longer than on plain work. The average building does not have so very much ornamental work in proportion to the complete number of yards, and a slight mistake on the front porch does not seriously affect the total.

Of course, no one ever thinks of measuring each baluster or spindle separately,—exactness is not possible on grilles and such work; and a painter who stands by actual surface measurement will yet run his rule across a row of spindles and forget to make any deduction. It is on such work that time is consumed.

A painter has sometimes to gild large balls with gold-leaf, and it is important to get the exact surface. For the surf of a sphere mult the sq of the diam by 3.1416. Thus a sphere 10 ft in diam has 314 sq ft, for 10 mult by 10=100, which mult by 3.1416 gives 314.16 sq ft. Another 5 ft diam has 78.54 sq ft.

A pack of gold-leaf contains 20 books, and each book has 24 leaves. A leaf is $3\frac{1}{2}''$ sq. Allow 50% for waste. A pack costs $8. Allow $20 a pack for putting on leaf.

Nos. 3 and 4 were not sublet, and I had exact figures for surface, material, and labor, but do not now have all of them at hand. I have some data from No. 2.

QUANTITY:—There are 2,000 yds of 3-coat white paint outside and inside on No. 2. Glass is not included, but only actual surface. Wages were 30c. The actual cost was 22c per yd. Labor was 13; material, 9c per yd. The work should not have cost more than 20c, but country painters are slow. The proportions were: Labor, $260; lead, $100; oil, $29.25; turpentine, $10.45; tools, etc, $15; pigments, $5. Putty should not run above 2c per lb.

If you ask a score of different painters how much material will be

required for a certain surf you will have a score of different answers. It is the same with all figures given in trade publications. So much depends upon the lumber covered that it is hard to be exact. If it is undressed it takes about twice as much as when it is smooth; inside painting takes less than upon a cornice where it may be applied with a whitewash brush. I was determined to have certainty for various surfaces where so many differed and wrote for a book written by a practical man. Before the end of his "practical" work he told his readers how to clean gold and clip sheep, but never said a word about quantities.

Two local agents allow 1 gal to 300 sq ft, 2 coats. It is too little on rough wood. A painter who has dealt in unusually large quantities informs me that 1 lb of lead covers 33 sq ft, and that each gal weighs 15 lbs., thus allowing 1 gal to 495 ft for 1 coat, or practically the same as the agents for 2 coats, because the material goes further on the 2nd. For mineral paint he estimates 675 sq ft on wood, and 900 on iron, 1 coat. These surfaces are at least 10% too large unless on very smooth wood or tin. Mineral weighs about 10½ lbs. For hard oil,—which now seems to be in disfavor—or varnish, his allowance is 700 sq ft, 1 coat. For varnish 500 ft at most is enough, although 5 gals recently covered 350 yds.

A firm of mixed paint manufacturers sends me the following data: "A gal of our paint weighs from 12 to 16 lbs,—white being the heaviest and dark shades the lightest. A gal will cover about 375 sq ft, 1 coat; 225, 2 coats; and 150, 3 coats, varying according to surf. Our roof and barn paints weigh about 12 to 13 lbs to gal, varying but slightly on account of shade. A bbl of mixed paint contains from 50 to 53 gals. A gal of our shingle stain is sufficient to dip about 400 shingles, or if used with a brush will cover 150 sq ft, 1 coat, or 100, 2 coats."

Their list contains more than 250 different colors. About ½ gal of oil for thinning is required for each 10 lbs of ready mixed paint.

Roofing paints are often adulterated. They should run about as high in price as linseed oil, which is usually from 60 to 70c per gal.

An old painter makes the following contribution to the sum of our knowledge: "Two coats require from 6 to 9 lbs to the 100 sq ft, 7 lbs being about the average. Add 3 lbs if 3rd coat is put on. The weight is given for paint already mixed. The first coat on new wood should have from 6 to 7 gals of oil to 100 lbs of lead; second coat about 5. A gal of linseed oil weighs about 7½ lbs, and estimating that the work will take 6 gals of oil to 100 lbs of lead, every 100 lbs of lead will make 145 lbs of mixed paint, the ground pigments for tinting perhaps making it 150 lbs, or about 10 gals. The labor for 1 man runs from 200 ft to 1,800, with an average of 1,000 in 10 hours."

Ten yards per hour per man is a good average on a plain building; but is low for ceilings, etc.

That is from a printed article; the following is from one of the best firms in Omaha: "Allow one gal of paint to 45 yds, 1 coat; the other coats do not take so much. For an 8-hour day average 35 yds for 1 man, but on certain classes of work he can do 100. On plaster with plain work he should do 150."

"Allow 1 lb of glue for 100 yds of size; 2 gals of boiled linseed oil for 100 yds of maple floor, 2 coats; 2 gals of varnish for 50 yds of inside finish, 2 coats; 1 gal of paste filler to 36 yds. Glue, 20c per lb. Berry Bros hard oil in bbls, $1.25 to $1.50 per gal; common wood-alcohol shellac, $1.75 in bbls; grain-alcohol white shellac, $2.90. Radiator enamel is $2.25 per gal, so that if this work is included the price of the raw material must be taken into account."Shellac covers more surface than varnish—allow ¾ gal of the one to 1 gal of the other. It is put on in about half the time.

Allow from 3 to 5 lbs of pigments for mixing 100 lbs of lead. The shade decides the quantity.

The time on plaster is reasonable. On 400 actual yds 74 hours were recently taken to size and give 3 coats of paint. Putting the 4 coats on the same basis that means 173 yds in 8 hours for 1 man. But again I saw 400 actual yards of plaster cleaned once and well painted 4 times and it took 176 hours, or at the rate of only 73 yards instead of 173. About 14 gallons of enamel were used for the last coat.

With large surfaces and no scaffolding required 175 yds of mineral is a fair allowance.

This painter gives 1 gal to 45 yds, 1 coat; the other, who handles large quantities of lead paint, gives his allowance at 55 yds. The weight is 15 lbs to gal. I find 3 different authorities who publish the following allowance, which the one has probably copied from the other: "1 lb to 4 sq yds for 1st coat; and 1 lb to 6 sq yds for each additional coat."

All the authorities agree on putty—5 lbs to 100 yds. Why should I try to be original? And yet if spikes have to be puttied it will take more than if wire nails are used. The allowance is for spikes, I think, or probably drift-bolts. I know that on No. 2 with 2,000 yds, without glass, only 10 lbs were used, but that is a brick building.

New brickwork requires about the same amount as wood. The first coat takes more, but the second less than on wood. Mineral paint is sometimes used on brick. Asphalt paint used on pipes, brick, etc, costs about 85c per gal.

For iron and steel allow per gal as follows, according to a popular work:

	SQUARE FEET	
	1 coat	2 coats
Pure linseed oil	875	
White lead ground in oil	500	300
Graphite ground in oil	360	215
Black asphalt	515	310
Iron oxide ground in oil	630	375
Red lead powdered	630	375

Approximately ½ gal of paint per ton of metal for 1st coat and ⅜ gal for second. For 1½ gals of graphite paint allow 5 lbs of paste and 1 gal of oil. Paste costs about 13c per lb. Steel mills charge about $2 per ton for 1 coat of paint. For cleaning old steel and iron bridges, etc allow 3c per sq ft of surface or approx from $1 to $1.75 per ton of metal.

Paint goes much further on plaster than on wood. On 700 yds 20

gals were used for 3 coats, but with a coat of size it is like painting on glass. This figure would not always hold out.

TO SUMMARIZE:—ALLOW 1 LB OF MIXED LEAD PAINT TO 1 YD OF 3-COAT work for plain painting or 1 gal to 16 yds. But with different surfaces it is impossible to give certainty. It took that amount on the large surfaces of No. 7 for 2-coat painting owing to rough steel, waste on high trusses, etc. Wood should never have less than 3 coats, although cottages are sometimes finished with 2.

Yellow ochre, sometimes used for priming, costs 3½ to 4c per lb. For priming 100 yds allow 15 lbs lead to 1¼ gal oil; for each additional coat add 33 lbs lead and 1½ gals oil. For 100 yds of 3-coat allow ½ gal turpentine.

CALSOMINING:—For 1 coat size and 1 calsomine allow from 60 to 80c per sq. To 150 sq ft, allow 1 gal calsomine.

PRICE:—Cost price of ordinary painting is now 7, 12, 17c for 1- ,2-, 3-coat work, with wages at 35c. Plaster, 20% less. Sanding, 1 coat, 15c. Painting in more than 2 colors is worth 15% more. Sizing, 2c per yd. Stippling is worth about 2c, but if there is a fair number of yds there is no extra charge made as the paint does not have to be so carefully spread.

But there are many kinds of painting. In white color it can be made to cost as much as $1 per yd, but painting of this kind lasts for a generation. Painting is still a trade among the best mechanics, but it is merely a daub among others. There are so many worthless compounds that if an owner has a reasonably sized pocket-book the best thing he can do is to go to a good painter and tell him to paint his building by day labor.

On average brush work with material at 2, labor runs to 3 and 4.

Mineral paint is cheaper than lead, but it is generally used only for the first coat on metal, or on large surfaces of undressed lumber. For 1 coat allow 5c; for 2 coats, 9c. A good mixture is Prince's or Rawlins mineral and boiled linseed oil. The mineral costs about 1c per lb. Allow 3 to 3½ lbs to the gal. Another good mixture is Sherman-William's mineral paste 1 gal to 1½ gal oil. Allow 1 gal to 60 yds. But on smooth tin it goes further than on wood.

Ready-mixed lead paint from the factories costs about $1.10 per gal in reasonable quantities, but small orders are sold as high as $1.50. Mineral runs from 70 to 75c, but the price is increased to the small dealer. Railways charge out their mixed paints at about 5c per lb. Colored paint can be made of stock that goes further than white lead, just as mineral does. A fair extra allowance would be 20% more surface.

SHINGLE-STAINS:—All the shingles on the roof of No. 12 were dipped. It was a slow process, but I neglected to keep the time and can not say exactly how slow. It is not only the dipping, but the shingles are much harder to handle after they have been dipped. Instead of being carried to the roof in a bunch they are taken by the armful. Allow 5,000 in 8 hours for 1 laborer.

One leading manufacturer asserts that his stain is 50% cheaper than paint. His quantities are as follows:—

1 brush coat, 1 gal to 150 sq ft of surface.

2 brush coats, 1 gal to 100 sq ft.

Dipping and applying 1 brush coat after shingles are laid, 3 gals to 1,000 shingles.

Dipping alone, 2½ to 2¾ gals to 1,000 shingles.

Only ⅔ of shingle is dipped. If applied with brush 2 coats should be used.

This manufacturer writes me: "These figures are as nearly accurate as it is possible to obtain. They have been proved by thousands of trials, and while, of course, the covering capacity varies slightly owing to the variation in the roughness and porosity of the wood, the difference is not great." Still it is better to allow 10 to 15% extra on quantities.

Prices per gal run from 65 to 90c. Green is the dearest. The manufacturer's time is half the allowance given for paint on same surface. The kegs or bbls contain 11 gals or more.

It is safe to allow $3 per 1,000, depending upon price of stain, etc. This runs covering of roof to $7 or $7.50. A good slate is $11, but rafters have to be heavier.

INSIDE WORK:—The figures already given are for a general average. If inside painting is taken alone it is worth 10 to 15% more, for better work is necessary. The paint figures are for 3 coats only; on inside work in white, 6 and 7 are not too many. Allow 10c extra for each coat. Striped work costs more, but fortunately it is not nearly so popular as it used to be—except on barbers' poles, where it still seems to hold its own. In this section of the country it is worth $12 to properly paint one, but a dozen can be done at half that figure.

A gal of liquid filler is enough for 50 yds; and in general 10 lbs of paste filler will cover the same surface, although 1,500 yds of hardwood on No. 3 took 500 lbs, but the glass was not deducted. Paste filler costs 10c per lb. Allow 1 gal varnish or hard oil to 50 yds first coat; to 55 or 60 for all other coats.

SASH:—190 windows, or 380 sash on No. 3 were stained in 100 hours. Stain is worth practically the same as linseed oil.

A gal of varnish weighs about 8½ lbs.

Before we set any prices it is well to remember that here, as elsewhere, unless otherwise stated, cost price is given, no profit being considered. Painters' wages were 35c per hour in Omaha up to May, 1903, but are now 40c.

The standard inside finish for hardwood is 1 coat filler; 1 shellac; 2 of varnish; rubbing down. If properly done it is worth 55c all through. It is often done for less, but neither material nor labor is first-class.

The banking room of No. 3 ran to nearly a dollar per yd. It was finished with 1 coat water stain; 1 filler; 3 white shellac; 2 rubbing varnish; rubbing down and re-touching afterwards, This is extra fine work with more coats than is usually put on.

But even when wages were 5c per hour lower than they are now,

$1.25 per yd—which included a good profit—has been charged all over interior work. First-class work is expensive, but it pays in the long run. All that glitters is not gold or even varnish. Some work may be made to cost $5 and upwards. It all depends.

On pine without filler the standard inside finish as above is worth 35c. The allowance for filling hardwood is thus set at 20c, which is exactly what all hardwood on No. 3 cost; but 15c ought to be enough if everything goes well. If rubbing down is omitted deduct 8c.

For 1 coat white shellac and 2 of Murphy varnish, 35c without rubb'g.

For 3 coats white shellac, which can not be rubbed, 35c.

For rubbing to egg-shell gloss, 10 to 20c; for slightly rubb'g, 6c.

For 1 coat filler and 2 of hard oil or varnish, 20 to 25c.

For 3 coats H O or varnish, 20 to 25c.

For varnish'g paint, 9c per coat.

For 2 coats floor finish, 20c.

For graining, 25c.

For enamel, 20c for 1st coat; 15c for 2nd.

For gold letters, 50c; silver, 50c; black, 20c, all per running ft.

Thus, a window 3 ft wide, lettered clear across, would cost $1.50 for gold and 60c for plain lettering.

Floors, ceilings, and such plain work can naturally be done cheaper than sash, grilles, etc. Rubbing down ornamental work costs 3 or 4 times as much as plain work. The foregoing prices are based on white shellac; common shellac is about half the price. Oil of any kind should never be put on floors. I have applied wax to parquet floors in my time, but the rubbing is rather tiresome. We did not fill the wood, but used wax only. It is usually filled here. After filling 1 lb of wax will cover 175 sq ft if well rubbed. The price is about 60c per lb; filler, 15c. From my recollections of the work, muscle is of more use than brains.

As the prices given are based upon 35c per hour, they can be regulated to suit any locality; or the number of yds can easily be found.

With liquid filler, on straight work, a man will fill 100 to 150 yds; with paste filler, 60 yds. For 1 coat of varnish, shellac or hard oil on plain work, 50 yds. About 30 yds is a day's work at plain graining.

The following material is required for 100 yds of graining; 4 lbs to 100 yds. Regular graining colors in oil are used. For rubbing down 100 yds:

5 lbs petroleum stock	3 lbs powdered pumice
1 gal kerosene	8 to10 lbs waste

STEEL-WOOL is sometimes used to rub down work by those who have little couscience or a low contract. It does not merely rub it down—it grinds it down. But steel-wool is not any too strong for some kinds of work. I recently saw 350 actual yards of oak cleaned down to the natural surface with a varnish remover. It works well unless there is shellac below the varnish, but it is a rather difficult matter to clean the wood. Each yard took an hour for 1 man. The work was done by contract and no time was wasted. Weather-oak stain after cleaning, 100 hours; giving 1 coat of shellac, 28; 1 of varnish, 76;

rubbing down to a fairly smooth surface, 86. The design was reasonably plain. If there had been balusters, grilles, and such work, twice the time would not have been sufficient. Twenty gallons of varnish remover were used, 3 gal shellac, with ½ gal alcohol to thin it, and 5 gal of varnish.

For plain wall-paper lapped, allow for labor 12 to 22c per roll; and for material, 10c and upwards.

Burlap, often supplied by painters for inside finish, costs about 32c per yd colored; plain, 23c. This is for 36″ width.

COLD-WATER PAINT

It is usually put on with compressed air, but a brush has to be used where finished work is apt to be spoiled with waste material falling on it.

On a surface of more than 4,000 yds, the material ran to $113 and the labor to $190, or 7c per yd for 2 coats with compressed air; but this does not include the cost of air. On a building with more than 1,000 yds done with a hand-pump the cost was 9c per yd for 2 coats. The material costs from 6 to 7c per lb, but large quantities can be bought cheaper. A safe figure is 5c for labor and 3 for stock.

With some kinds of cold-water paint mixing takes more time than painting.

In the use of compressed air the labor depends a good deal upon the ease with the work can be reached. On the building with 4,000 yds inside there were 1,200 yds of brick, actual measurement, outside. The labor for 2 coats of lead and oil was only $12, but 150 gals of mixed paint were used. The coat was about 12c per yd, or say, 13c with cost of air. The experience at the World's Fair in Chicago showed that for large, plain surfaces this method is far ahead of the old one, but it soils everything within reach. Of course buildings differ. On the same building, owing to considerations of accessibility the outside cost is, as we have seen, 1c per yd, and the inside 4¾c, but the men had to crawl among rafters.

Quantities for large work may be estimated from the following data: On 16,000 yds 7,000 lbs were used, or .44 to sq yd, brush. On 7,800 yds 4,200 lbs were used, or .54, brush; on 5,700, 2,200 were used, or .4, brush; on 4,000, 2,100 were used, or .525, compressed air.

All work was 2-coat on brick and lumber. Actual surf only is given—openings being deducted. But joists have to be measured both sides, not merely taken with the surface of the ceiling. In some cases the one item is larger than the other. The largest quantity was used on No. 7, and the other allowances on buildings close by. The difference between quantities for compressed air and brush is not so great as is sometimes necessary.

On the 33,500 yds 15,500 lbs were used, or a little less than ½ lb to the yd. This is a safer figure than any of the 4, for while the total quantity was used for the total surface the distribution between the various buildings might not be exact.

A manufacturer's catalog at hand gives the following data: "For smooth, hard boards allow 1 lb for 50 to 75 yds, 1 coat; for rough bds, stone and brick, 25 to 40 yds. Allow 2 parts powder to 1 cold water."

According to these figures 1 lb will do from 3 to 8 yds, 1 coat; according to the actual results given for 2 coats, ½ lb covers 1 yd. But much depends upon the proportion of material. Suppose it is reversed and 2 parts cold water used to 1 part powder?

Bbls weigh from 350 to 400 lbs; kegs, 100. Half bbls and kegs are also standard, and smaller amounts are packed in wooden cases.

LABOR:—On one building the labor it already given. On No. 7 it ran for 2 coats cold water, 4½c per yd, but scaffolding was included for high roof. On another building, 4c; on still another, 6c. Two coats lead, by hand on No. 7 ran to 10c, but the trusses were hard to reach, although several thousand yds of plain steel-work reduced their high average. Labor on lead and oil on another building with plain surface ran to 8½c; but wages were not more than 30c.

BRUSHES:—Each painter is supposed to own a putty-knife and duster; the rest of his outfit is supplied by the employer. Allow for each man for outside work:—

2 8 O round brushes.
2 flat, 4 to 4½″.
1 No. 10 sash-tool.
1 or 2 flat-chisel sash, 1½.

For inside work:—

1 8 O chisel varnish brush.
1 flat varnish, ½″.
1 flat varnish, 2″.

CHAPTER XVI.
HARDWARE

Simmons' old catalog has 367 pages 7½x11 devoted to builders' hardware—and they have given us a new one for 1904; Spencer & Bartlett's, 118 pages, 6x8; and Lee-Glass-Andreesen's new book, which is a credit to Omaha and Nebraska, has 240 pages 7½x11. These are only 3 out of many. They are all packed full of information about hardware, and more is to be found at the retail stores. And we are not only burdened with a hundred different kinds of hinges, but each has from a dozen to a score of different finishes, and it is seldom that 1 price covers more than 1 article. The very hardware men, who are specialists, are wearied of the endless variety. It is with a sense of relief that a contractor reads in a model specification that shelf hardware is to be covered by a certain sum, or else supplied by the owner.

NAILS:—Wire nails are now used almost everywhere. I have heard, however, that the engineering department of the B. & M. R. R. still clings to the Rip Van Winkle kind which, according to the tests, take a firmer bite.

I kept an account of nails on only 1 building—No. 10. There it took 1 keg to 2,600 ft of lumber of all kinds. Probably the proportion would run on such work ⅓ of spikes and ⅔ of 8D and 10D. The whole building is frame, although the lower story is veneered with brick; with less spiking a brick building would require a larger proportion of nails.

If anyone desires a close estimate of nails he may easily find it as the following table gives the number per pound, but different tables give different numbers. There are so many joists or studs; each board requires so many nails; 5% allowed for extras and waste will give the number of kegs at 100 lbs to keg.

To illustrate by the floor of No. 7: There are 320 planks in width,

and 100 sleepers to which they are nailed; but planks run from 12 to 16′ long, and it is therefore safe to allow 7 extra nailings clear across the space, because each joint requires twice the number of spikes. Each plank has 2 spikes, or 640 to a sleeper, a total of 68,480; with 5% additional, 71,904. The table gives for 60D spikes, 12 to lb, making a total of 60 kegs. Or having the lf of flooring, allow 1 nail, or 2 nails, as the case may be, to every bearing.

Matched flooring and ceiling, unless wider than 5¼ or thicker than ⅞ have only 2 nails to each bearing.

Allow for 6″ siding, 18 lbs to 1,000; 4″, 25 lbs of 6D. Shingles require 4 to 5 lbs of 4D to 1,000; 3 to 3½ of 3D. Lath, 8 to 10 lbs of 3D fine.

If joists or studs are 12″ centers more nails are required than for 16, so that tables are not reliable unless this is stated.

On looking up some of the books I bought before I began this venture of making one for myself I was greatly pained to see that they are too like each other on this absorbing nail question to be credited with the independent investigation that the importance of the subject warrants. Here is the stock table—if it is not correct, blame the authorities.

The allowances are for 1,000 ft bm.
Dimensions lumber, from 3 to 25 lbs.
Sheeting, 20 lbs 8D; 25 of 10D.
Flooring, 15 to 35 lbs; 38 of 10; 42 of 12D.
Finishing, 30 lbs 8D finish.
1,000 ft 1x2 furring 65 of 10D; 1x3, 45 of 10D.
100 lf base, 1 lb; 1 lb to door; ¾ to window.

I find from the method already explained that at 12″ centers, ⅞x6″ flooring nailed 1 edge, requires 26 lbs of 10D, and 17 of 8D nails; 4″ flooring or ceiling, 40 of 10D, 26 of 8D, 15 of 6D. At 16″ centers, 6″ flooring, 20 lbs of 10D, 13 of 8D; 4″, 32 of 10D, 22 of 8D, and 11 of 6D.

Of course the number of nails to lb varies; 106, 74, 10, are given in another list instead of 132, 87, 12 as above.

The price of nails changes as the days go by. At present the "base" is $2.60. From 60D to 20D is base. Add according to table for other kinds.

WIRE NAILS:—Size, length, number to pound, and rate:

Size	Kind	Length, Inches	Number to Pound	Advance on Rate
60	Common	6	12	Base
50	"	5½	15	....
40	"	5	21	....
30	"	4½	27	....
20	"	4	35	....
16	"	3½	51	.05
12	"	3¼	66	.05
10	"	3	87	.05
8	"	2½	132	.10
6	"	2	252	.20
4	"	1½	432	.30
3	"	1¼	720	.45

Size	Kind	Length, Inches	Number to Pound	Advance on Rate Base
3	Fine	$1\frac{1}{8}$	1140	.50
10	Casing	3	121	.15
8	"	$2\frac{1}{2}$	170	.25
6	"	2	310	.35
4	"	$1\frac{1}{2}$	584	.50
10	Finish	3	137	.25
8	"	$2\frac{1}{2}$	190	.35
6	"	2	350	.45
4	"	$1\frac{1}{2}$	760	.65

BOLTS:—Bolts are not measured between nut and head for length, but from under head to extreme end. Countersunk bolts are measured over the head. Rods threaded both ends are measured from point to point. Machine-bolts, 2 to 3c per lb. Drift-bolts, 2c lb; boat-spikes, 3c per lb. LAG-SCREWS:—2 to 5c per lb. See tables for weight of round iron.

CAST WASHERS

Price:—$1\frac{1}{4}$ to 2c per lb.

$\frac{1}{2}$ inch	$\frac{1}{2}$	lb	each	$1\frac{3}{4}$ inch	$9\frac{1}{2}$	lbs	each
$\frac{5}{8}$ "	$\frac{3}{4}$	"	"	2 "	$17\frac{1}{4}$	"	"
$\frac{3}{4}$ "	$1\frac{1}{4}$	"	"	$2\frac{1}{4}$ "	20	"	"
$\frac{7}{8}$ "	$1\frac{1}{2}$	"	"	$2\frac{1}{2}$ "	$27\frac{1}{4}$	"	"
1 "	$2\frac{1}{2}$	"	"	$2\frac{3}{4}$ "	36	"	"
$1\frac{1}{8}$ "	3	"	"	3 "	46	"	"
$1\frac{1}{4}$ "	$5\frac{3}{4}$	"	"				
$1\frac{1}{2}$ "	6	"	"				

Weights are different: These are Jones & Laughlin's; the Union Pacific $\frac{3}{4}''$ washer, for example, is only $\frac{3}{4}$ lb and so on in proportion to size.

Manufacturers' Standard List of Wrought Washers.

Price:—4 to 5c per lb.

	Weight		Weight
$\frac{1}{4}$	13,900 to 100 lbs	1	625 to 100 lbs
$\frac{3}{8}$	6,800 to 100 lbs	$1\frac{1}{8}$	520 to 100 lbs
$\frac{1}{2}$	2,600 to. 100 lbs	$1\frac{1}{4}$	400 to 100 lbs
$\frac{5}{8}$	1,300 to 100 lbs	$1\frac{1}{2}$	260 to 100 lbs
$\frac{3}{4}$	1,010 to 100 lbs	2	175 to 100 lbs
$\frac{7}{8}$	860 to 100 lbs		

Small washers cost from 30 to 50% more than large.

SASH-WEIGHTS:—The wts of cast iron carried in stock run from 3 to 24 lbs. Price about $1\frac{1}{2}$c. Standard wt is round. Square wts are special and cost about 1.75c per lb, and round wts over 22 lbs are same price. If few, allow 2c. To get size of square wts find half the wt of sash and the extreme possible length of sash wt in inches. Divide an assumed wt of 48 lbs by .26 and we have the number of cu inches necessary to balance 1 side of a 96-lb sash. This is divided by 24, the assumed length, and the sectional area is found to be nearly $7\frac{3}{4}$ inches. We must now find a number which mult by itself will produce 7.70 for a sq wt; or if it has to be $2''$ thick, it will be $3\frac{7}{8}$ wide. A sq wt would be 2.78 inches,

or a trifle more than $2\frac{3}{4}$. A knowledge of sq root is useful for more than rafter lengths, for we can not always carry a load of books around. The main windows of No. 3 weighed from 350 to 400 lbs; and doors on No. 4 weighed more.

Where boxes are small lead weights have sometimes to be used, but the price is 6c per lb. Lead weighs about 50% more than wrought iron

The following table for lead will save the trouble of calculating weights

Size in inches; wt in lbs per lf:

Size	Round	Square	Size	Round	Square
1	$3\frac{1}{2}$	4.93	$2\frac{1}{2}$	23	30.82
$1\frac{1}{4}$	6	7.68	$2\frac{3}{4}$	28.93	37.27
$1\frac{1}{2}$	$8\frac{1}{4}$	10.27	3	34.81	44.38
$1\frac{3}{4}$	$11\frac{3}{4}$	15.08	$3\frac{1}{4}$	40.52	52.07
2	$15\frac{1}{2}$	19.02	$3\frac{1}{2}$	47.26	60.82
$2\frac{1}{4}$	$18\frac{1}{2}$	24	$3\frac{3}{4}$	54	69.33

SASH-CORD:—There are many kinds, and each manufacturer says his is the best. The usual hank contains 100 ft, and weighs from 2 up to 3 lbs. A 3-16 cord weighs $1\frac{1}{2}$ lbs to the 100 ft; and a $\frac{3}{8}$, 5 lbs. Average price, 25 to 30c per lb.

Sash-chain costs per ft about 8c in genuine copper; for wt up to 125 lbs.

Sash-chain, copper steeled, 3c.

Steel retinned chain, 5c.

Steel-ribbon, 5c up to 125 lbs.

DUMB-WAITERS:—Without rope or car, to carry wts up to 100 lbs, $15.

WALL-PLUGS:—$16 per 1,000.

INSIDE SLIDING DOOR-HANGERS:—An average hanger is worth $4.50 with track and bolts complete; with some hangers a wide opening runs to $5.50. A Coburn, $2.60 for single door 4-6; $4.20 for 6-ft double door.

A COBURN BARN DOOR-HANGER is worth $2.25 without track; track, 10c per ft.

JAMB-GUARDS:—For 8′ long, $3\frac{1}{2}''$ wide, with anchors, $1.50 each.

BARBED WIRE:—For 4-point cattle, painted, $1\frac{1}{8}$ lbs to $16\frac{1}{2}$ ft; galv, $1\frac{1}{4}$ lbs. Hog, $1\frac{1}{4}$ to $1\frac{1}{2}$. For 2-point cattle, painted, 1 lb; galv, 1 1-16. Hog, 1 1-32 to $1\frac{1}{8}$. Price $3\frac{1}{2}$ to 4c per lb. Staples of average size 100 to lb, 4c.

COMMON WIRE:—Price, $2.90 per 100 lbs.

SHELF HARDWARE:—"In making out bills of hardware take each room separately and indicate each door or window where special stuff is required, and the hardware will be packed to suit."

"A door is left-handed if when viewed from the outside its hinges are on the left. The outside of a door is that side which is approached on entering a building or room. The outside of a door between rooms is the side opposite to that from which the knuckles of the butt are visible. All doors opening out should be designated as reversed doors." A front door does not usually open out, but if it did it would be a reversed door.

In ordering certain classes of hardware it is necessary to specify right or left.

Since we can not read several thousand pages of descriptive matter, or explore as many sq ft of shelving, is there no way of getting some fair idea on the price of shelf hardware?

The following figures embrace pretty much all that the contractor is apt to meet in a specification. For several years I used just such a list as is presented here, and found it to work satisfactorily. Changes can be noted on it as the days go by and prices rise or fall. With some the danger is to put bronze finish in the place of real bronze. There is not so much difference between the various finishes of iron. Taking bronze-plated goods as a standard polished old-copper runs about 5% more; sand old-copper, 15 to 20, while Boston-finish and steel-finish, are about the same as bronze-plated. Real-bronze goods belong to another class. Some have had to pay for this information.

HINGES OR BUTTS

4x4 japanned, 20c per pr; 30 in bronze finish; $2.00 in real bronze.
4½x4½ 25c per pr; 35 in bronze finish; 2.25 in real bronze.
5x5, 35c per pr; 50 in bronze finish; 2.50 in real bronze.

Double-acting Chicago butts, jap, per pr, 1¼ door, $1.20; 1¾ to 2″, $3; bronze-plated, etc, $3 for 1¼; $5.75 for 1¾ to 2; old-copper finish, unpolished, $2 and $4.30; antique-finish, sand-blast, $3 and $5.60 for same thicknesses. But a blank is often used with a butt as 1 is strong enough for the door, and this reduces the price. Blanks are about half the price of butts. Real-bronze butts of this kind are seldom used.

The Chicago floor-hinge is used with spring at bottom and plate at top. For thin doors, $1.40 each door; for 2″ doors, $1.75 japanned; in plated, antique copper, $1.75 and $2.10.

These hinges must not be confused with screen-door goods which are sold from $1 to $2 per doz prs.

Sometimes smaller butts than 4x4 are used. On 4 lists running from 3½x3½ to 5x5, the bronze-plated goods are in cents; 13, 14, 15, 20, 24, 30c per pr; old-copper finish, 13, 15, 19, 23, 28, and 30c; polished and bronzed with ball tips, 19, 23, 24, 28, 31, and 43c; old-copper, sand-fin, ball tips, 16, 18, 20, 25, 30 and 34c.

For wrt-steel loose-pin butts, used on ceiling doors, etc, the price is low: 2x2, 5c per pr; 4x4, 12c. In small quantities a higher price may be charged.

WRT-BRASS BUTTS:—Open hinge, get exact number of sq inches, and mult by 1½c for price of each hinge—not pr. These hinges are narrow, middle, broad and desk. Narrow, 1″ long, 2c per pr; 2″ long, 3c; 3″ long, 8c. Middle, 2″ long, 3c pr; 3″, 10c. Broad, 2″, 4c; 3″, 12c.

LOCKS:—A GOOD RIM-LOCK with knobs and plain, jap trim, 20c. Inside good door-lock, fit for any door, $1 with real-bronze trim complete; a larger size, $1.50. Front door-lock, $3.50; but a good one may be had for half that figure if real bronze is not desired. There are others that cost $5, and without much searching of shelves $20 could be spent on a front door.

SLIDING DOOR:—$1.50 to $3 and upwards. Sliding door-latches are a trifle cheaper, just as they are for ordinary doors.

It is not necessary to pay even $1 for a mortise-lock. With jet knobs and bronze-plated trimmings a lock good enough for cottages may be bought for 30 to 40c.

The Corbin "Unit" lock is something new. It is in 1 piece, and is merely cut in the edge of the door and the long escutcheons screwed in place. It looks well, but a carpenter objects to weakening the framework of the door. The lock costs about $6 or $7.

A STORE DOOR-LOCK with trimmings complete may be bought for $5 in bronze; but $8 is the least that should be estimated for a good building. From this price we may run to $11, $15. and as high as we choose. A bronzed lock complete may be bought for $1. Dead-locks for stores, without trimmings, 85c each.

THE MASTER-KEYED LOCKS on No. 2 were $2.75 each without trimmings. Common, bronze face, $1.25.

DRAWER-LOCKS:—A really good article is worth 60c.; from that they are sold down to 10c. A good cupboard lock is worth 30c.

Sometimes a combination of various goods is made; the following prices will be a help:

ESCUTCHEONS:—Real-bronze for key only, 35c to 45c per doz; imitation, 25c; jap, 12c. For key and knob, real, 5½ to 6″, $1.25 to $2; in various sizes with imitation finishes, 65 to 75c per doz.

PUSH-PLATES:—3½x10, $7.20 to $8.40 per doz, real; imitation, $5. Persian-bronzed, $2. Larger sizes run from 35c each in imitation to $1.75 in bronze metal.

DOOR-KNOBS:—Mineral, porcelain and jet knobs with jap mountings, run from 75c to $1 a doz; wrt-bronze metal, $4.25 to $5.50; jet knobs with bronze mountings, $1.75; bronzed wrt-iron knobs, $3. Better qualities of standard, bronze metal knobs run to $8 per doz.

DOOR-SPRINGS AND CHECKS:—Blount, $4 to $6.40, according to thickness of door. Corbin combined, $2.10 to $5.60; Eclipse check, $1.25 to $2.50; Eclipse springs, 75c to $1.60. Eclipse spring and check go together.

TRANSOM-LIFTS:—Bronze iron, ¼x3′ and 4′, 20c ea; 5-16x4, 30c; ⅜x5, 50c ea. With copper finish, add from 5 to 10c ea.

FLUSH-BOLTS:—50 to 75c each in imitation; $1 to $1.50 in real. There are smaller and cheaper flush-bolts.

CHAIN-BOLTS:—30% cheaper than flush-bolts.

BARREL-BOLTS:—From 5 to 12c each.

SASH-LIFTS:—Flush, imita, 75c per doz; real, 75c to $3.

BAR-LIFTS:—Imita, $1.50 to $2.10; real, $3 to $4. Persian-bronzed, $1.20 per doz.

HOOK-LIFTS:—Imita, 1c to 3c ea; real, 5c to 10c ea.

SASH-LOCKS:—Imita, 60c to $1.50 per doz; real, $1.75 to $3.25.

PULL-DOWNS:—2c each.

AXLE-PULLEYS:—$1.25 per doz down to 25c. Large sizes should be used.

SASH-BALANCES:—They rise according to wt of sash. For ordinary

20-lb sash, \$1.25 to \$1.75 per set for 1 window complete. They run as high as \$12 for large sizes.

SASH-CENTERS:—15c per pr.

DRAWER-PULLS:—Imita, 50c doz; real, \$1.25. But there are many kinds and prices.

WARDROBE-HOOKS:—Wire, 15c per doz; cast-iron, 40c.

BRASS TRACK:—6c per ft; sheaves, 10c each.

SHELF-BRACKETS:—4x5, 10c pr; 8x12, 30c; 16x20, \$1.

SCREWS:—From ½″ to 1½, 20c per gross; 1½ to 3″, 40c. These prices are for bright-iron screws of average wt—the price of extra-heavy screws may run up several times as much. Brass screws cost about twice as much as iron.

HEAVY STRAP-HINGES:—Allow 4 to 5c per inch of length per pr for an approximate figure; light, 25% less.

HEAVY TEE-HINGES:—4 to 5c per inch of length. Take extreme length folded in each case.

MORTAR HOES:—60 to 75c each.

MORTAR WHEELBARROWS:—\$2.75; common brick, \$2.50.

PAILS:—35c to 75c.

SHOVELS:—90c, upwards and downwards.

BRICK HODS:—80c; mortar, 95c.

ROPE:—Manila, 15c per lb; sisal, 13c. The relative strength of Manila and sisal is 7 to 5. Approx wt of 1,200 ft—a full coil:

3-16	¼	⅜	½	⅝	¾	⅞	1″	1¼	1½	1¾	2″
18 lb	25	45	100	160	200	300	360	570	800	1,200	1,500

CHAPTER XVII
PLUMBING AND GAS FITTING

Some plumbers' and steam-fitters' catalogs have several hundred pages of descriptive matter and price-lists. Why expect more here than a mere glance at a subject which requires so much space if treated exhaustively? We may, however, set down some things that are not found in the catalogs which are full of an embarrassing wealth.

SEWERAGE:—About the smallest trench that can be used is 18″ wide by the necessary depth. Digging and backfilling mean so much more than the laying of the pipe that if they are carefully figured the rest is easy. In fair ground with a depth of 5 ft 50c per cy is enough, and 5c per lf for the laying of the pipe. If sheet-piling is used allow from 5 to 10c per cy extra. But too much depends upon the character of the soil to set any hard and fast figures. In soft ground an Omaha plumber allows 10c per lf for 6 ft deep; and 30c to a depth of 14 ft. But these figures are too low, although for excav only. Of course they are reasonable if plenty of tunneling can be done. On 1,000 ft of pipe laid by another plumber to a depth of 5 ft, the time was 220 hours, or less than 6c. On 1,400 ft of pipe recently laid only 1 ft deep the cost of excav and laying without cost of pipe, was 10c per lf which is too high a figure. Laying of 12″ pipe is worth 7 to 10c per ft; 4″, 5c.

Some work recently done in wet soil at a depth of from 4 to 5 ft with 6 and 10″ pipe cost for excav and laying 28, 31, and 43c, with more than 1,000 ft in each case. But suppose that rock has to be cut? Or

that 100 ft of a sewer are only 4 ft below the surface, while the next 100 have to go through a deep bank? Each job has to be estimated to suit the local conditions.

After a depth of 6 ft is reached the earth has to be handled twice, and a scaffold built in the trench to hold it. (See Chap 6 for prices of Omaha sewers.)

WATER-PIPE:—The time is practically the same as on sewer-pipe of same depth. Some plumbers allow less for water- than for sewer-pipes. The pipes come in 12 ft lengths, and a good deal of boring can be done if the soil is fair. For 5 ft deep 12c ought to be enough under ordinary conditions and digging the whole length. But this price is sometimes doubled and trebled owing to one cause and another. A long straight line can be laid cheaper than many short lengths. On several thousand ft of 6 and 10″ recently laid the labor ran to 35c per ft; and on 500 ft to 48c. This included,—like the foregoing figures,—excavation, laying and backfilling.

A fair idea of what laying is worth may be obtained from the following figures put in by 8 bidders for 1903 work in New Hampshire. Price is given in cents per ft: 3,100′ of 12″, average 36c, from 30 to 43c; 4,800′ of 10″, aver 33c, 27 to 41; 2,800′ of 8″, aver 30c, 23 to 38; 10,000′ of 6″, 27c, 20 to 35; 4,300 of 4″, 24c, 19 to 32.

On a contract in another part of the country the price ran, 12″, 33c; 10″, 25c; 8″, 22c; 6″, 20c; 4″, 19c.

On 11 bids for 10,000′ of 48″ in Boston the successful figure was $2.25; highest was $3.53; average, $2.73.

For ordinary supply-pipes to a building 8c per ft is a safe enough figure in fair soil; only about half the line is excavated and the rest bored with an auger thus reducing the cost per ft.

Inside of a building a man will lay 100 ft of lead supply-pipe in a day. If galv iron is used allow about same.

SOIL-PIPE:—It is hard to give a figure that will apply to all buildings. How many branches are there? How many bends and angles? Or is it in a straight line? Sometimes a plumber will take a day to 40 ft; again he may do 100; a fair average is 50 ft. A good deal depends upon the size—4 and 6″ are given above. Soil-pipe has to run a distance of 4 ft outside of buildings in Omaha. Sewer-pipe is not allowed inside a building. The weights for extra-heavy pipe are: 2″, 5.5 lbs; 3″, 9.5; 4″, 13; 5″, 17; 6″, 20; 8″, 33.5; 10″, 44; 12″, 54. An 8″ pipe is nearly 3 times as heavy as a 4″, and this counts in the labor.

VENT-PIPES:—When run singly they are from 1¼ to 2″ diam. Allow 75 ft in a day for 1 man; 4″, 45 ft; 6″, 40; 8″, 35.

WASTE-PIPES:—For water-closets, 4″; cesspools and slop-sinks, 2″ and 3″; other fixtures from 1¼ to 1½. The time on waste-pipes is included in the fixture time.

FIXTURES:—"Allow $10 for connecting up each fixture all supply and soil-pipes being in place ready to connect." Sometimes the work can be easily done for half; a fair average is $5, but residence work costs a trifle more than warehouse. Wash-basins in ranges should be connected at rate of 2 in 8 hours for 1 man.

A water-closet ought to be connected for $5. A plumber should do the work in $\frac{1}{2}$ day; $\frac{3}{4}$ of a day is ample. It should never take a whole day unless at a far distance from the shop, for plumbers usually report there in the morning instead of at the building. A day's work should be 3 closets, all rough pipes being in place. Not so long ago safes had to be put below water-closets, and it took longer time to finish; but now open plumbing is universal, and usually compulsory. In ranges allow about same time.

All pipes being ready a bath tub should be set for $2. For a house with bath, water-closet, and wash-bowl in bath room; with sink and boiler in kitchen; and water-closet and sink in cellar, allow 6 to 12 days for 1 man to rough in and finish complete; 9 is a good average.

SLATE:—Setting per sq ft costs about 10c.

DOORS:—Hanging water-closet doors, 8 of pine in a day for 1 carpenter. Some men will do 10.

TUBS:—To set a range of 3 laundry tubs, 1 day.

METER:—To connect a small meter for house, $3; a large one for factory, $10. The Omaha Water-Works Co. connects meters free of charge.

HYDRANT:—To connect yd hydrant, $2.

PUMPS:—To connect a pitcher pump, $1.20.

Plumbers' wages are 55c per hour; helpers', 20 to 25c. For an approximate estimate allow from 20 to 25% of the cost of material for labor—but some bath tubs cost $30, some $150, while labor is about the same. Plumbing and heating run about 10% of cost of building.

MATERIAL

CAST-IRON SOIL-PIPE, SINGLE-HUB

Size in inches	2	3	4	5	6	8	10	12
Price per ft, standard	13c	17c	21c	32c	37c	70c	$1.10	$1.60
Price per ft, extra-heavy	15c	28c	35c	50c	56c	1.22	1.62	2.16

Extra-heavy is almost always used, so that the caulking can be done without bursting the pipe.

DOUBLE HUB

Standard	16c	20c	24c	36c	45c	80c	$1.62	$1.90
Ex-heavy	21c	37c	45c	66c	76c	1.22	1.95	2.49

Both single- and double-hub pipe comes in 5-ft lengths. On average work allow 35% of straight pipe for all fittings; water-pipe, from 38 to 40%; vent-, 45.

SEWER-PIPE

Inside diam.	Straight pipe	Curves	Traps	Weight per ft.
3	5c	16c	55c	6 lbs
4	7c	19c	66c	9 "
5	8c	24c	80c	12 "
6	10c	32c	90c	16 "
8	13c	48c	1.26	23 "
10	19c	67c	1.90	33 "

Other fittings may be approximated from the foregoing list. Junctions are about 15% more than curves; double junctions, 50%; and increasers, decreasers, and slants, about the same.

CAST-IRON WATER- AND GAS-PIPE

AVERAGE WT OF PIPE AND JOINTING MATERIAL

Inside diam. Inches	W per ft Water	Wt per ft Gas	Lead for ea joint in lbs	yarn in oz.
3	15 lb.	13 lb.	3½	6
4	22 "	18 "	4½	7
6	32 "	30 "	8	9
8	42 "	40 "	11	11
10	60 "	50 "	15	13

Weight of fittings for water-pipe for the 5 sizes given: Elbows—40, 70, 102, 205, 260; bends—50, 80, 133, 201, 300; sleeves—24, 40, 70, 120, 150; plugs—8, 12, 20, 40, 60; tees—3″, 60; 4, 115; 4x3, 85; 6, 190; 6x4, 155; 6x3, 140; 8, 260; 8x6, 250; 8x4, 235; 8x3, 190; 10, 430. Crosses—75, 120, 109, 225, 200, 175, 325, 285, 255, 206, 565, to suit the 11 tees given.

The wts for gas-fittings are from 10 to 15% lighter than for water.

Cast-iron pipe comes in 12-ft lengths. The wts vary 5% either way. The price of pipe is about 2c per lb; of fittings, 3c.

WRT-IRON PIPE FOR STEAM, GAS, AND WATER

BLACK AND GALVANIZED:—The following prices are for black pipe; when galv it costs about 40% more:

	Standard		Extra-Strong	
Inside Diam	Wt per ft in lbs	Price per ft in cts	Wt per ft in lbs	Price per ft in cts
⅛	.24	2.25	.29	7
¼	.42	2.25	.54	7
⅜	.56	2.25	0.74	7
½	.84	3.3	1.09	7½
¾	1.12	4.	1.39	9
1	1.67	5.5	2.17	13½
1¼	2.24	7.3	3.	18
1½	2.68	9.	3.63	21½
2	3.61	12.7	5.02	30
2½	5.74	20.	7.67	49
3	7.54	24.	10.25	63
4	10.66	39.	14.97	90
6	18.76	68.	28.58	1.74

Double ex-strong is about 50% more in price and wt than ex-strong.

LENGTHS:—From 16 to 20 ft; average 18.

CUTTING AND THREADING:—Each cut and thread up to ¾, 3c; 1, 3¼c; 1¼, 3½c; 1½, 4c; 2, 6c; 3, 12c; 6, 32c. This threading is done by a machine; when done by hand it is worth at least twice as much. Couplings are about 30% lower in price than 1 ft of straight pipe of same size; small ells are lower, large ones higher than straight pipe; small unions, about same,—large, 50% higher; tees, about same, except in larger sizes which are higher; crosses, same in small pipe, twice as high in large.

GLOBE-VALVES:—1¼, $1.25; 1½, $1.60; 2, $2.50; 2½, $5.60; 3, $7.70; 4, $9.

GATE-VALVES:—1½, \$1.60; 2, \$2.50; 2½, \$3.65; 3, \$4.40; 4, \$6.25; 6, \$9.75; 8, \$16.
SMALL LEAD PIPE:—8c per lb.
WATER-CLOSETS:—Which of more than 400 styles is to be taken as a standard? Siphon-jet, wash-down, and wash-out are the 3 leading styles. A good siphon-jet closet with tank, pipes, etc, complete may be bought for \$25; other styles may be had for \$20; some people with more money than sense might find their ideal at \$70. A wash-out closet costs about \$15. These prices do not include setting. Low tanks being almost noiseless are coming more into use.
URINALS:—Earthenware urinals are of different sizes and styles. They run from \$4 to \$6 ea. If slate urinals are used the slate must be taken by the sq ft and the fittings allowed extra.
SLATE:—At the thickness of 1″, 50c per sq ft; 1¼, 60c; 2″, 80c.
ITALIAN MARBLE:—⅞, 80c; 1¼, \$1; 2, \$1.50.

Slate partitions are 4 ft high by various widths, from 14″ to 4 ft, 6 in.

Allow 10c per sq ft to set slate; marble is used for basin-tops and such trimmings. In general the cost of putting it in place is included in fixture allowance.

Water-closet doors run to about \$8 per pr finished by painter. If hinges are of best quality nickel-plated, allow \$4.50 per door—not per pr of doors. Nickel-plated standards to keep slate up from floor, \$2 ea. They are 14″ long. Rail on top of slate partitions, 40c ft. Angles and bolts to hold slate, 30c each.
BATHS:—There is no limit to the cost of baths. Enameled tubs may be had for \$15 in 4 ft; \$20 for 4 ft 6 in; \$24 for 5 ft; \$25 for 5 ft 6 in lengths, with all necessary trimmings. Long baths are seldom used now. In porcelain the same sizes would cost about \$150.

Shower-baths are a trifle cheaper than tubs, and if a cement floor is put down they can be used where the space is limited. With a single pipe \$10 might buy a bath of this kind. In a recent and excellent work, "Municipal Engineering & Sanitation," by M. N. Baker, associate editor of "The Engineering News," this style of bath is recommended on account of its cheapness. It would seem to be necessary in our summer climate if Mr. Baker's statistics are correct; for it appears that only 3 to 5% of houses in such cities as Baltimore and Boston have baths. The building codes ought to be so amended that all new houses should have at least some cheap bath. St. Louis has set a good example in this way.

LAVATORIES:—Square, with marble slab and back, brackets, basin and all fittings, \$15; corner, \$18. With floor-slab, etc, from \$50 to \$75. Porcelain is much dearer. Enameled iron, from \$10 up.
BOILERS:—For galv-iron boilers used in kitchens with stands, couplings and tubes; 30 gals, \$7.50; 40, \$10; 52, \$16; 79, \$24. The same sizes with coils are worth additional: \$8.40, \$9.60, \$12.80, \$14.40. These prices are for standard boilers; ex-heavy cost 20% more.
SINKS:—For kitchen-sinks, enameled-iron, the usual size of 18x30, allow \$2.40. There are many varieties, sizes, and prices.

Roll-rim sink with back, $10; with drain-board and back full length, $19.

LAUNDRY TUBS:—Price of 2 part, $17; 3 part, $25, including standards and all fittings.

Sheet lead, 7c; solder, half and half, 20c per lb. Kidder gives 7 lb lead to sq ft for roofs and gutters; 6 for ridges; 4 for flashing.

WATER-METERS:—Small ⅝ meters for dwellings are sold by the Omaha Water-Works Co. at $11.50 ea.

GAS-PIPE:—For all pipe 1″ and under allow 12 to 15c put in building complete. An average day's work for 1 man is 80 ft; it was formerly set at 100, but now the day is shorter.

CHAPTER XVIII.

HEATING AND LIGHTING

The heating systems in ordinary use are steam, hot-water, hot-blast, and furnace. Heating by electricity is a matter for experts to deal with.

PRICE:—The price of pipe is given under "Plumbing." Standard wrt-iron pipe is used—not extra-heavy. The number of feet of radiation being obtained an approximate price of work in place may be found by mult by 75c per ft without boiler; 85c with boiler. Plain buildings do not quite reach these figures, but dwellings with hot-water heating often run to $1. Hot-water is higher than steam by 15 to 35% as more radiation is required. Boilers are sold at all prices. A hot-water boiler for 1,000 to 1,200 ft radiation can be furnished and set for $180 to $190.

RADIATORS:—They are of many kinds and sizes. The standard hight is 38″. In the catalogs the number of sq ft is given for each loop or section. Allow 25c per sq ft for radiator without valves and fittings. Allow 3 ft of 1¼″ straight pipe as an equivalent of a sq ft, and price pipe-radiators same as the newer style.

Radiator-valves run from 50c to $4. A fair valve may be bought for $1.50. Steam valves are the most expensive. Hot-water, 1″, 76c; 1¼, $1.08; 1½, $1.50. Steam: 1″, $1; 1¼, $1.25; 1½, $1.70.

Radiator-pedestals or feet, are from 5 to 15c each. Pipe-hangers from 8 to 15c each.

When a pipe is over a certain length an expansion-joint is required. The expansion averages 1 inch in 50 ft. The price is regulated to some extent by the expansion or "traverse." For 10-inch traverse allow the following prices: 3″ pipe, $12; 4, $20; 5, $25.50; 6, $32; 7, $40; 8, $48. But a 10″ traverse is longer than the standard which for a 3″ pipe is 2¾; 4″, 3¼; 5″, 4; 6″, 5; 8″, 7. The price of a 3″ ex-joint is about $6.50; 4, $10.50; 5, $17; 6, $19.50; 8, $39. All prices given are for iron body, brass sleeves and flanges—screwed joints are from 10 to 50% cheaper. Brass expansion-joints are sometimes used for the smaller sizes. They run about 50% higher in price than iron.

COILS:—Allow 30c per sq ft for 1″ coils of fair length, set in place.

PIPE-COVERING:—The best has 85% magnesia coupled with 15% of other constituents. The price delivered in Omaha is for 12″ pipe, 65c; 10, 56c; 8, 50; 6, 40; 5, 36; 4, 28; 3, 23; 2½, 19; 2, 17; 1½, 14; 1¼, 12. A cheaper covering is asbestos and woolen felt: 2″, 9c; 2½, 10; 3, 11;

$3\frac{1}{2}$, 13; 4, 14; $4\frac{1}{2}$, 15; 5, 16; 6, 18; 7, 22; 8, 24; 9, 26; 10, 32c. Wool felt is often used to cover cold-water pipes.

These prices include canvas covering and metal bands. An ell is worth about the same as a lf of same size; a tee and valve about 30% more; a cross from 60 to 70 more than a straight ft; but for such angles the raw material is usually plastered on—a bag of raw material costs about $4. Sections of covering are made 3 ft long. Plain 1″ lagging for boilers and such work is worth about 21c per sq ft put on. Magnesia and asbestos coverings are used above ground; for underground work Wyckoff covering is better. It is made of asbestos in a hexagonal wood duct from 8 to 12 ft long. For new work the pipe is put in on end—for work in place the box is split. Allow for raw material: 4″ pipe, 32c; 5, 38; 7, 52; 8, 59; 10, 76. The box is, of course, larger as these sizes are for pipe. Sometimes asbestos is used below ground in a box, but Wyckoff is better. Allow lumber at regular price, and 5c per lf for carpenter labor alone.

LABOR:—For laying 3 or 4″ pipe in a box several hundred ft long without a turn, allow from 3 to 6c per ft. The lengths are merely to be screwed together. No. 2 has about 300 ft of 6″ hung to girders in a tunnel; allow about 12 to 15c. When such lengths are used an expansion-joint is necessary.

For inside of a building allow for risers, etc, from 8 to 10c per ft. The lengths are short and require extra labor. A radiator should be connected for $1.50 to $2 for steam, which is usually connected at only 1 end; for hot water 50c more ought to be sufficient.

Radiators weigh about 7 lbs to sq ft; allow $5 per ton for hoisting.

As with all kinds of work short material and angles take most labor. The estimator must make allowance for the character of the job. Approximately allow 25% of price of material for labor. Wages are 50c per hour for fitters, and 25c for helpers.

From 4 to 7c ought to cover digging and laying of box for pipe; or for Wyckoff covering, as trench does not require to be deep. Allow for pipe. Pipe-covering ought to be put on at 3c for small pipe up to 8 or 10 for the largest sizes; but everything depends upon the number of angles.

For the heaviest kind of work, with pipes from 2″ to 16″, allow 25% of total cost of material for labor. On a very large equipment with steam-, water-, and air-pipes, this was exact figure.

RADIATION

There are various rules for obtaining the number of ft of radiation required. Each room is sometimes taken by itself on a different basis; again glass is considered, and its surface with respect to total wall exposure; and Baldwin sets a rule that the wise stand by. A building divided into small rooms requires more than a large hall or room. Halls and sleeping-rooms are not heated so much as parlors. Some take the cubic ft and divide by 60, and up to 100, or even 150 for large spaces; others go as low as 30 for a unit. The quotient gives the number of sq ft required for steam; hot water requires 20 to 25% more. For ordinary buildings divide the cubic ft by 40 and mult the sq ft of radiation

thus obtained by $1 for the cost with boiler. Plain buildings are sometimes heated with coils for as low as 4c per cf without boiler. An exact estimate can be had by making a piping plan and taking off the material and labor in the ordinary way. Both steam and hot water can be installed with either the single or dbl-pipe system. The water may be returned to the boiler in the same pipe by which steam or hot water is supplied, but a heavier pipe is required, and many experts prefer the 2-pipe system.

For steam allow 35% of straight pipe for fittings, for hot water, 40. When there is little time to take off a bill in detail this will serve for an estimate.

The pipe radiator is not so much used now, as the others serve for both steam and water instead of steam only as it does. Each loop or section has from 5 to 10 sq ft of heating surface, varying with hight and width, so that a price can not be set without size and number of loops if the work is taken in detail.

HOT-BLAST:—I have had something of a prejudice against the fan system since No. 3 was built. There the hot air was pumped from the basement at such a rate that it went through the roof without having time to call in the offices. The tenants used to sit with their overcoats on while the fireman worked below without a shirt, throwing coal into the ''Nebuchadnezzar" as fast as the wagons could haul it. The coal, overcoat, and vacant-office bills ran so high that the system was torn out and steam put in its place. I have been assured that office-buildings are now successfully heated by this system,—the 13-story Builders' Exchange at Buffalo, for example;—but having once shivered, I want to be shown, if the Missourian phrase may be allowed in a hot-air d scussion.

But for halls, schools, theaters, manufacturing buildings, etc, the system is a success if carefully installed. Nos. 7, 8, and 14 are heated with it. As a rule the manufacturers put in the plant themselves. An average figure for complete system is from 7-10c to 1c per cu ft. But this does not include any boilers or supply-pipes leading from them. There are various methods of installing the plant; sometimes ducts are used below the floor; sometimes pipes overhead. Prices vary according to plans.

FURNACES:—Approximately, allow $16 per room in houses for furnaces ready for lighting. Same may run more, some less,—5 to 7 rooms about $18. The heating capacity is found by cubing the entire house if it is all to be heated. The figures in the first column of the following table give the outside diam of the furnace casing; in the second col the number of cf heating capacity; in the third col the price del'd at building, but not set. There are, of course, a hundred different styles with as many different claims, so that some allowance has to be made for a departure from an average type.

36 inches	10,000 to 12,000 cf	$56
40 "	12,000 " 15,000 "	67
42 "	15,000 " 18,000 "	80
44 "	18,000 " 23,000 "	94

48 inches 23,000 to 30,000 cf $109
50 " 30,000 " 40,000 " 120

A margin of safety is allowed, however, as a furnace should not be driven to the limit. A 40″ is usually put in a 5- to 7-room cottage complete at $117. A soft-coal furnace is a little cheaper than one for hard coal.

Pipes of an average size may be estimated in place at 25c all through. These are double; 6x22 single, lined with asbestos paper, 35c in place. An easier way is to allow $3.50 to $4 per run for all pipes to first floor; and $8 to second, including box and shoe.

Elbows run from $3 to $6 per doz; 8″ and 9″, about $ 3.50.

After material is made ready it does not cost much to put it in place; average 8-room houses run from $20 to $28 for all labor on furnace, pipes, and registers. One roll of asbestos paper is sufficient for the large pipes when they are used. The carpenter sometimes makes the fresh-air duct from the nearest window.

There are about 35 furnaces to a car-load.

There are many kinds of registers; but a fair idea of value may be had from this list:

Size in inches.	Register	Reg-face	Floor-border
4x 8	$0.45	$0.18	$0.28
7x10	.50	.30	.32
9x12	.63	.41	.39
10x12	.72	.45	.41
10x20	2.69	1.32	1.16
10x24	3.65	1.54	1.54
12x20	2.70	1.35	1.20
12x24	3.66	1.56	1.56
16x30	8.00	3.60	3.60
18x36	11.40	4.65	3.60
30x30	15.00	5.40	4.85
38x42	36.00	15.00	11.00

These prices are for black-japanned; white-jap are 20 to 30% higher; gold, silver, copper, nickel-plated, or bronzed-finish registers are also about 30% more than black-jap. There are many other finishes and designs with special prices. The ordinary wall-frame is 2″ deep; 4″ costs about 50% more.

LIGHTING

ACETYLENE is conveyed in pipes the same as gas, so that that part of an estimate goes on the 12- to 15-cent a foot price as gas-pipes do. The basis for usual illumination is 25-candle power to each square—the incandescent lamp is rated at 16-candle power. A room 10x10 lighted with acetylene would therefore have more than 1½ incandescent power. Burners are $4 per doz. Fixtures are of all prices like those for gas and electricity.

The generators FOB Omaha run about as follows:

For 35 light	$120	For 75 light	$200	For 150 light	$360
" 50 "	140	" 100 "	240	" 200 "	400

The installation of the generator is merely a case of lowering it into place and connecting it. It is easier set than a small furnace.

Sometimes a double generator is used and that runs up the price, but makes a better plant. Then some manufacturers put in better material than others, or charge a higher percentage for their work. With good fixtures complete I have seen bids for 150 lts, dbl generator at $784; 200, $822; 300, $894; 400, $1,000; and again a plant to run 75 to 100 lts, single generator, with fixtures complete for $425.

The government has lighted Fort Meyer, Va., and 14 Indian schools with acetylene.

ELECTRIC LIGHTING

Allow $2.50 on average house work, for each lt with wiring, switches, cut-outs, sockets, etc, complete. This is for open work, weather-proof wire. For concealed work with rubber-covered wire, $3. For open work, wire only, $2 per lt. These prices are per lt, not outlet, as an outlet might have half a dozen lts. No. 14 wire is used for ordinary work. An arc lt costs about $30. It is impossible to set a figure on the work for such buildings as Nos. 7 and 8; and the bids showed that even experts do not agree on values.

CHAPTER XIX
TILING

PRICE:—Out of 18 designs at hand 17 run from 50 to 65c per sq ft of hearth-tile FOB Omaha. The exception is a white body and white and gold for a border. That runs to 80c. The sand and cement are to be added, and also the laying. Usually everything has to be prepared for the tilelayer up to within 1 inch of finished surface, so that there is only ½″ to ¾″ of mortar. A layer and helper should finish a hearth in a day; with 2 in a house 1½ days are usually sufficient. But time is taken up going from building to building as the work does not last long. The surface is small, so that profit can not be made very large at best; expressage is to be paid both going and coming, and store rents are always collected. Allow from 75 to 90c per sq ft in place for the average hearth. All these hearth prices include border.

FLOORS:—Marble tile, black and white, about 10x10x⅞, 45 to 50c per sq ft laid with ½ of cement. Tennessee marble, 6x6, with concrete, 60 to 75c per sq ft.

Cement tile laid on 2″ of concrete 28c for square blocks about 10x10; for octagon, 2c less. Concrete from 2 to 3 inches deep is put from 7 to 8c per sq ft and included.

Hexagon, white, vitreous tile, 3 inch, with concrete, 70 to 75c—on a large piece of plain work 50 to 55c is enough.

Hex, buff, unglazed, 3 inches, with concrete, 40 to 45c.

Encaustic tile, including 2 inches of concrete, 45 to 50c.

Contractor's profit is included in the foregoing prices, which are for work done or from bids put in.

But the size of tile has to be considered. The factory list has 4 divisions according to number of pieces in a sq ft; 4 to 65; 65 to 129; 129 to 513; 513 and more. The following vitreous list, FOB Omaha, will give a fair idea of the difference in price:

White, cream.	36c	48c	60c	72c
Silver gray.	37c	49c	61c	73c
Celadon, sage, light green, light blue	43c	55c	68c	80c
Dark blue, dark green.	52c	54c	76c	91c
Pink.	58c	71c	83c	96c

In plain colors, semi-vitreous, 7 varieties, 4 divisions: 24c, 40c, 54c, 70c
THICK TILE:—$\frac{3}{4}$, 30c; 1″, 35c; unglazed in 7 plain colors. Glazed tiles are worth from 30 to 60% more than unglazed.

Imitation mosaic tiles from 30 to 55c per sq ft.

Inlaid tiles, unglazed, above $1\frac{1}{2}$ x$1\frac{1}{2}$,from 70c to $1.50, depending upon the colors. Glazed, from 30 to 60% more.

Round tile are sold at the same rate as sq tile of same size.

Enameled tile in the 4 divisions run 50c, 65c, $1.30, $1.85. These prices are for various colors; ox-blood, red-enamel is about 15c per sq ft extra in each division.

For antique or dull-finish tiles on white body add 25c per sq ft to enamel prices.

Out of more than 100 floor designs with unglazed tile the lowest price is 24c and the highest 65c. Most are between 25 and 35c. Borders are the same, or a little more or less, depending upon the pattern.

Ceramics, $\frac{1}{4}$″ thick, mounted on paper or twine, run to 35c per sq ft in several dozens of patterns. Borders are about the same. These tiles are usually about $\frac{3}{4}$ to 1 inch round, sq, or hexagon.

Ceramic, mosaic, enameled tile are about 3x$\frac{1}{2}$x$\frac{1}{4}$ and cost 65c.

For all kinds of floor-tile add 10c per sq ft if less than 25 sq ft in order. Letters or numbers, 10c each.

WAINSCOTING:—With cap and base included from 55 to 65c per sq ft. Special designs are of course higher in price, but the foregoing prices FOB give a beautiful piece of work in enameled and majolica. But white enameled 6x2 can be set complete on a good sized piece of work for 65c; white opalite about 10c less; and there are wall-tiles at 40c set; 75c to $1 is safe.

MANTEL-FACINGS:—Here we enter the region of high art with prices to correspond. For the 6x6 size 17 tiles are allowed to a mantel; for the $4\frac{1}{4}$x$4\frac{1}{4}$. 26. For the set, enameled, from $2 to $6; gold decorated, $8 to $12; Palissy decorated, $4; gold and Palissy, $12. But in renaissance the prices soar from $10 to $50. If special designs the cost is even more.

DECORATED TILE:—Palissy, embossed, from 80c to $1.75 per sq ft; gold, $1.50 to $3; gold and Palissy, $2.15 to $3.75. Solid gold on plain tile, $4 to $5. Hand-painted work is priced according to the reputation of the artist.

BASE, CAP, COVE AND BEAD-TILES:—The prices run from 12 to 25c for each piece 6″ long, Angles are 50% dearer. These prices are for glazed or enameled tile—gold decorated work is from 2 to 3 times as much more.

MEASUREMENT:—An accurate plan should be sent to the factory. One plan is better than 10 letters. Tile should be measured by the sq ft; cap and base for wall-tile may be taken by the lf, each tile figured

6″ long. Special care must be taken with all angles, stops and returns.
QUANTITY:—There is always waste in laying. The factory sends 2% more than enough to cover the surface unless special orders to the contrary are given, so that this extra must be included in the price. Tile, unlike pressed brick, may be returned. One bbl of Portland cement will lay 100 ft of tile. Make mortar 1 to 1. Concrete should be 3″ deep, of 1 to 3 if natural cement is used. (See Chap 3.) Wood strips are required for guides. The "Tile Manufacturers of the U. S." specify Keene's imported cement for wall-tile joints.
"FACTS ABOUT TILE." Enamel and wall-tiles when packed weigh about 5 1-5 lbs to ft; plain unglazed floor-tiles, about 6 lbs; vitreous floor-tiles, $6\frac{1}{2}$. Ceramic, mosaic, tiles, $\frac{1}{4}$″ thick, $2\frac{3}{4}$ lbs to ft; plain and vitreous floor, as well as enamel and wall-tiles, are about $\frac{1}{2}$ thick. A large bbl holds about 85 ft of wall- or enamel-tile; small bbl, 50 to 60 ft; large bbl, 60 ft of plain unglazed tile; small bbl, 52.

Concrete is often put down upon a rough wood floor; sometimes the floor or support is cut in between the joists; again, expanded-metal is used: the base must be estimated in its proper place separate from tile. All work is usually prepared to within 1″ of finished surface for the tiler, unless a specially thick tile is used. Allow $\frac{1}{2}$ for mortar in all cases.
LABOR:—The prices already given, unless otherwise specified, are FOB Omaha. Hauling, mortar, and labor are to be added. Ceramics are not much more difficult to lay than ordinary tile for they are all mounted on paper or cord.

Number of pieces of different sized tile in a square foot.

Size	In a Square Foot	Size	In a Square Foot	Size	In a Square Foot
6 x6	4	9 x3	$5\frac{1}{3}$	2 x1	72
$4\frac{1}{4}$ x$4\frac{1}{4}$	8	$7\frac{1}{4}$ x$3\frac{5}{8}$	$5\frac{1}{2}$	$2\frac{1}{8}$ x$1\frac{1}{16}$	64
3 x3	16	6 x4	6	$1\frac{1}{2}$ x $\frac{3}{4}$	128
$2\frac{1}{8}$ x$2\frac{1}{8}$	32	6 x3	8	6 in. oct.	$4\frac{4}{7}$
2 x2	36	6 x2	12	$4\frac{1}{4}$ in. "	$9\frac{1}{7}$
$1\frac{1}{2}$ x$1\frac{1}{2}$	64	6 x$1\frac{1}{2}$	16	3 in. "	$18\frac{2}{7}$
$1\frac{1}{16}$x$1\frac{1}{16}$	128	6 x1	24	6 x3 hex.	$10\frac{2}{3}$
1 x1	144	6 x $\frac{3}{4}$	32	6 in. "	$6\frac{1}{6}$
$\frac{3}{4}$ x $\frac{3}{4}$	256	6 x $\frac{1}{2}$	48	3 in. "	24
$\frac{1}{2}$ x $\frac{1}{2}$	576	$4\frac{1}{4}$ x$2\frac{1}{8}$	16	2 in. "	54
6 diag.	8	$4\frac{1}{4}$ x$1\frac{1}{2}$	$22\frac{3}{5}$	1 in. "	205
$4\frac{1}{2}$ "	16	$4\frac{1}{4}$ x$1\frac{1}{16}$	32	3 in. lozenge	$18\frac{1}{2}$
3 "	32	$4\frac{1}{4}$ x $\frac{3}{4}$	45	3 in. triangle	37
$2\frac{1}{8}$ "	64	4 x4	9	$1\frac{1}{2}$ in. "	144
2 "	72	3 x$1\frac{1}{2}$	32	$\frac{3}{4}$ Round	250
$1\frac{1}{2}$ "	128	3 x1	48	Stars	44
$1\frac{1}{16}$ "	256	3 x $\frac{3}{4}$	64	Cross	63
1 "	288	3 x $\frac{1}{2}$	96	$1\frac{1}{2}$ Round	$81\frac{1}{2}$
$\frac{3}{4}$ "	512	3 x $\frac{1}{4}$	192	Cusps	298
$\frac{1}{2}$ "	1152				

CHAPTER XX.
ODDS AND ENDS

MINERAL WOOL:—This is a fibrous material of the nature of glass. Wood strips are sometimes used and must be included in est according to thickness of wool on floor. Sometimes strips are nailed on sides of joists and boards laid across to support the wool in the same way that almost all houses in the United Kingdom are deafened with cinders and mortar. Details should be seen before est is made. Floor is at least 1½″ thick. Outside walls are often packed full width of studs.

Allow 1 lb per sq ft for each inch in thickness, but deduct all openings, chimneys, studs, joists, etc, and proceed on exact surf. The material is packed in 3-bu bags, for which a price of 10c is charged, but as with hard plaster, etc, they are returnable at cost if freight is prepaid. The following table gives wt, price, etc:

AVERAGE	Lbs. per Cubic Foot	Square Foot 1 inch thick	Cubic Feet to Ton	Cost per 100 lbs. (in ton lots) at Factory	Cost per Cu-Foot at Factory In ton lots
Ordinary Slag Wool .	12	1 lb	166	$1.00	12c
Selected Slag Wool. . .	9	¾ lb	223	1.67	15c
Extra Slag Wool. . . .	6	½ lb	333	4.00	24c
Ordinary Rock Wool	12	1 lb	166	2.00	24c
Selected Rock Wool .	8	⅔ lb	250	4.00	32c
Extra Rock Wool . . .	6	½ lb	333	7.00	42c

Note.—In less than ton lots add 25c per 100 lbs to factory prices.

The wool usually put in buildings costs about $17 per ton FOB Omaha in car-load lots—30% more in small lots. A minimum car-load is 10 tons. The labor of putting it in place varies according to thickness. It may be averaged at 12c per cf, although floors should not cost more than half. But both for labor and material it is necessary to watch ceilings as joists are sometimes stripped with a band of corrugated iron, stapled on edge with metal lath below and wool laid on top of lath. Strip is at least 1″ wide, but sometimes 2 for fire protection. Staples for lath may have to be 3″ long.

Brick walls are sometimes furred, double boarded with paper between, then lined with mineral wool between studs, and boarded on face before finishing. This to emphasize the necessity of seeing full details. The complete cost of protecting a house is set at from $75 to $250 according to size.

DEAFENING QUILT:—This material is made 1 yd wide and bales contain 500 sq ft. Single-ply bales occupy about 8 cf of space, and cost about 80c. Double quilt weighs 125 lbs per bale, and costs $1.20.

UNLOADING:—Given the proper place, car, and facilities, we are now assured that a car of earth can be emptied for 1c. Building contractors have neither place, car, nor facilities for this kind of work.

To unload crushed stone from cars allow from 20 to 25c per ton.

More than 1,000 tons on No. 7 and other buildings were unloaded for 20c. Equal quantity of sand cost 10c. But sand costs more in winter. On some of the cars for No. 2 the sand froze in such shape that it cost twice as much to move it. At all times bank sand is easier handled than river sand. The one is worth 5c per yd more to handle than the other. On railroad work earth and ballast are dumped from cars for 10 to 16c. Loading of gravel, 7 yds for 1 man in 10 hours.

BRICK:—Allow 25c per 1000 to unload from car and put on wagon; loading at brickyard is worth from 25 to 40c.

SLATE:—See Chap 14.

LUMBER:—Allow 50c per M for 2″ lumber; $\frac{7}{8}$ is worth about 75c.

WRECKING:—Each building has its own environments—only a hint can be given Allow for brick basement and frame above, 3c per sq ft where everything is handy; twice that price might not be enough. For 2- to 3-story brick buildings, 5 to 8c. If work is laid in good cement more time is taken than if old, lime mortar falls out of joints. On a high wall the cost of carefully taking down 185,000 brick wall measure was $450. Then the inside might be full of well-framed carpentry, or might be vacant. For 1-story brick 3½ to 4c ought to be enough if there is no basement. In general the brick taken out of old walls do not more than half pay for wrecking and cleaning.

RAISING ROOFS:—For heavy roofs about 20 to 30 ft from ground allow 8 to 9c per sq ft of floor surface.

ELEVATORS:—For hand elevator 4x4 to 5x5 with 2,000 lbs capacity, 1-story building, erected complete, $125 to $140. Allow $10 additional for each extra story. For 8x8, 5,000 lbs capacity, electric, with motor, 1-story, $1,300 to $2,000. Safety gates extra, about $35 a floor.

Sliding-ladders used along the front of hardware shelves, etc, cost from $15 to $20 each. A single ladder costs more than several.

BONDS AND INSURANCE:—Something was said in the introductory part about insurance. It is now necessary to give the cost of fire, accident insurance, surety bonds, etc. As soon as a building is enclosed it may be insured for the regular rates and periods. An owner sometimes does this, and the contractor finishes his work without expense for insurance. Sometimes, again, insurance has to be taken out as payments are made on the work, and the owner puts this on the contractor's shoulders. Annual policies can be taken out by contractors as work goes along and cancelled at short rates when the job is safely accepted and paid for. In Omaha the charge is $1 per $100 for 1 year on all kinds of property for builders' risk.

The short-rate scale is the same as it was 15 years ago, as I find on referring to an old list, but the annual premium is now less. The rate is given for about 50 periods.—for our purpose a few are sufficient:

For	5	days	7%	of	annual	premium.
"	10	"	10%	"	"	"
"	15	"	14%	"	"	"
"	20	"	17%	"	"	"
"	30	"	20%	"	"	"
"	40	"	26%	"	"	"

For 50 days		28%	of annual	premium.
" 60 "		30%	" "	"
" 70 "		36%	" "	"
" 80 "		38%	" "	"
" 90 "	or 3 months,	40%	" "	"
" 120 "	" "	50%	" "	"
" 150 "	" "	60%	" "	"
" 180 "	" 6 "	70%	" "	"
" 240 "	" 8 "	80%	" "	"

But the $1 rate is on basis of houses distant from each other at least 25 ft; if between 25 and 15 add 5c more for each exposure; under 15 add 10c. Thus a house under 15 on 2 sides would be rated at an annual premium of $1.20 per $100.

ACCIDENT INSURANCE:—A guarantee is given to protect contractor from all damage suits and verdicts in return for a premium based upon wages paid during a year which is usually taken as a unit. A policy may be taken out for $1,000 or $100,000 of wages. When the specified wages are paid a new policy has to be taken out, as the basis is for an amount of money and not for a period. On a small amount like $5,000, the rate is about 3½%; on a large amount, 2½.

SURETY-BONDS:—For small bonds about 1% is charged; for large, half as much. A millionaire can get a bond at a lower rate than a man with only $50 capital. Formerly the premium for the bond covered the whole expense until the building was finished and accepted; now an endeavor is made to again collect the premium at the end of a year. A careful understanding as to whether rate is annual, or for accepted building should be seen to, and a receipt taken.

CHAPTER XXI
STANDARD SIZES AND GRADES

Since the British took hold of Egypt it has been transformed into a new country full of all kinds of triumphs, engineering at Assouan and other elsewhere. There are still plenty of oppressed people in Egypt, but they have brothers in all civilized lands. Much of the credit for the advance is due to Lord Cromer. He has brains in his head, and he is not afraid to use them. He recently told his English countrymen that if they wanted to keep abreast of Americans in bridge-building, making of locomotives and such work, they would have to follow the American plan and standardize their patterns. Some of the men he addressed had been complaining that Americans were getting contracts in the land where of old Jacob got corn.

The theory is correct. After the pattern is made it serves for many castings as easily as for 1. Only 1 drawing has to be made, and this too is worth noting. With standards in plenty and telegraph codes multiplying on all sides, it will soon come to pass that half a dozen words will mean an order for a 40-page specification and a complete bill of material for a 5-story building. Cromer is not blind.

CUT STONE:—The sizes are marked on plans, for most of it is special; but if not specified window sills are 5″x7″ for ordinary walls, but always wide enough to reach about 2″ under the wood. The lugs extend 4″

on each side into the brickwork. If thicker sills are wanted the size must be marked.

Door sills are $7\frac{1}{2}''$ thick and of width to suit the thickness of the wall—11″, 15″, 19″. They extend about 1″ outside of brick, and should always, unless for some special reason, join with the floor below the door so that joint can not be seen from outside or inside. They extend 4″ in on each side like window sills and lintels.

Lintels are 8″ in hight by thickness to reach to the face of frame, thus giving the mold for cover.

Unless otherwise specified ashlar may be used all over only 4″ thick. An ordinary front is laid in 4 and 8″ blocks.

BRICKWORK:—In the majority of American cities the national size is now standard, although some makers still use their old sizes in spite of law which makes $2\frac{1}{4}$x4x$8\frac{1}{4}$ compulsory for common brick. For the sizes of pressed brick, see Chap 5.

A bbl of Portland cement weighs 376 to 380 lbs net, and comes in 4 sacks of cloth or paper if not barreled.

Natural cement weighs about 266 lbs for western and 300 for eastern brands, and is delivered in 2 cloth, or usually 3 paper sacks.

Lime weighs about 200 lbs, and equals $2\frac{1}{2}$ bus.

LUMBER:—There is so much trouble and confusion with sizes and quality of lumber that it is worth while to clear up a few points,—but those who know how the lumbermen themselves quarrel over grades will not expect much here.

It would, of course, be absurd to change the design of a building to suit the standard lengths of lumber; but sometimes without going so far a useless waste might be avoided if architects would only remember that it comes with a difference of 2 ft in length. It sometimes seems that it might be cut to the odd as well as to the even sizes; but lumbermen know their own business best, and we have to accept what they give.

But unless for a weighty reason why make a space 19′ 8″ instead of 19′ 4″? In some cases there is no possibility of changing the width, and the material must be lost; in others it might just as well be made to suit 20-ft joists. It is not always best to space purlins exactly the same; sometimes by the change of a few inches 2 ft of lumber can be saved on both sides clear across a roof hundreds of feet long. This 24″ difference in length is worth some attention when dealing with flooring, ceiling, shelving, etc. The lengths upon which prices are based are 12, 14, 16; lumber 10′ long usually costs more, because it has to be cut from 20-ft lengths. Above 16 the price rises, and the longer the timber the higher the price. But Oregon fir is priced on a base of 32 ft instead of 16, as with other material in this market. For yp, the "Association" rules are:

> "The standard lengths are multiples of 2 ft, 10 to 24 ft, inclusive, for boards, strips, dimension, joists and timbers. Longer or shorter lengths than those herein specified are special. Odd and fractional lengths shall be counted as of the next higher even length.
>
> On stock width shipments of No. 1 common and better lumber, either rough or dressed 1 or 2 sides, no piece shall be admissible

that is more than $\frac{1}{4}''$ scant on 8″ and under; $\frac{3}{8}''$ scant on 10″, or $\frac{1}{2}''$ scant on 12″ or wider. All 4″ and wider, No. 2 common stock may go $\frac{1}{2}''$ scant in width."

Flooring and ceiling are never more than 16′ long; above that length is special, and more so than with dimension lumber. It is necessary for both architect and estimator to watch the spacing of the first joist at the wall, and especially if mill construction with centers of 4 to 8 ft is used. The flooring or ceiling has to reach the wall, past the center of the wall-joist; and therefore the spacing must be from the wall or else the ceiling and flooring will only reach the edge of the further joist; and with wide centers this means waste.

When ordering large quantities of flooring or ceiling it is safer to give the proportion of lengths that will be accepted, or the whole bill may come in 12's.

The following sizes are from the lumbermen's printed list for yp; 95% of southern lumber is graded and classified according to these rules:

STANDARD SIZES OF DRESSED LUMBER

FINISHING:—1″ S1S, or 2S to 13-16, $1\frac{1}{4}''$ S1S or 2S to 1 3-32, $1\frac{1}{2}''$ S1S or 2S to 1 11-32, 2″ S1S or 2S to $1\frac{3}{4}''$.

MOULDED CASING AND BASE:—13-16. 1x4 S1S shall be $3\frac{1}{2}''$ wide, finished; 1x6 S4S shall be $5\frac{1}{2}''$ wide finished.

FLOORING:—The standard of 1x3, 1x4 and 1x6″ shall be 13-16x$2\frac{1}{4}$, $3\frac{1}{4}$ and $5\frac{1}{4}''$; $1\frac{1}{4}''$ flooring shall be 1 3-32″ thick.

DROP-SIDING:—D and M $\frac{3}{4}$x$3\frac{1}{4}$ and $5\frac{1}{2}''$.

DROP-SIDING:—Shiplap, $\frac{3}{4}$x5″ face, $5\frac{1}{2}$ over all.

PARTITION:—$\frac{3}{4}$x$3\frac{1}{4}$ and $5\frac{1}{4}''$.

CEILING:—$\frac{3}{8}''$ ceiling, 5-16″; $\frac{1}{2}''$ ceiling, 7-16″; $\frac{5}{8}''$ ceiling, 9-16″; $\frac{3}{4}''$ ceiling, 11-16″. Same width as flooring. The bead on all ceiling and partition shall be depressed 1-32 of an inch below surface line of piece.

BEVEL SIDING:—To be made from stock S4S to 13-16x$5\frac{1}{2}$ and resawed on a bevel.

WINDOW- AND DOOR-JAMBS:—Dressed, rabbeted and plowed as ordered, worked $\frac{3}{8}''$ scant of width.

BOARDS AND FENCING:—1″ S1S or 2S to 13-16″.

SHIPLAP:—8, 10, and 12″. 13-16x$7\frac{1}{8}$, $9\frac{1}{8}$ and $11\frac{1}{8}''$.

D AND M:—8, 10, and 12″. 13-16x$7\frac{1}{8}$, $9\frac{1}{8}$, and $11\frac{1}{8}''$.

GROOVED ROOFING:—10 and 12″ S1S and 2E to 13-16x$9\frac{1}{2}$ and $11\frac{1}{2}''$.

DIMENSION:—2x4 D1S and 1E to $1\frac{5}{8}$x$3\frac{5}{8}''$; 2x6 D1S and 1E to $1\frac{5}{8}$x$5\frac{5}{8}''$; 2x8 D1S and 1E to $1\frac{5}{8}$x$7\frac{1}{2}''$; 2x10 D1S and 1E to $1\frac{5}{8}$x$9\frac{1}{2}''$; 2x12 D1S and 1E to $1\frac{5}{8}$x$11\frac{1}{2}''$; 4x4 and 4x6 D1S and 1E to $\frac{3}{8}''$ off side and edge; S4S $\frac{1}{4}''$ off each side."

Dimension lumber comes from $\frac{3}{8}$ to $\frac{1}{2}''$ less than the specified size, for, in Omaha, at least, it is always surfaced on 1 side and 1 edge. If wanted rough it has to be so ordered, and the price is $1 extra per 1,000 on account of freight charges. This applies to yp. With Oregon fir it is different, for it is never surfaced unless so ordered; but it is surfaced on 1 to 4 sides as required. While yp loses from $\frac{3}{8}$ to $\frac{1}{2}''$ in surfacing 1 side, Oregon fir is surfaced 2 sides with a loss of only $\frac{1}{4}''$. Thus yp 8x12 would come about $7\frac{1}{4}$x$11\frac{1}{4}$, while Oregon fir would be $7\frac{3}{4}$x$11\frac{3}{4}$. But again, the

Oregon figures are not always reliable; the price list calls for ¼ extra on each side for surfacing if exact dressed size is required.

About 10 years ago the Omaha architects made a fight against this surfacing, and specified that no joists would be accepted under 1⅞″ thick; but they had to end by accepting market sizes which will be sustained by any court. The remedy is to place the thin joists closer together,or to specify 2¼ thick; and in either case the price is increased, the owner refuses to build, the architect is in danger of losing his percentage—and eagerly accepts any thickness and turns his eyes in the other direction.

Drop siding and shiplap come about the same as flooring of equal width. While 6″ shiplap is a standard size it is never seen in this territory; 8″ is usual; 10″ is seldom handled.

SIDING:—6″ siding is 5½″ wide; 4″, 3½.

Sheeting or common boards come about the same as dimension lumber—½″ narrower than the theoretical size. Here it is worth while to state that sheeting and sheathing are not the same, although often used for each other. Sheeting is sheathing; but sheathing may not be sheeting. According to the latest dictionary it may be tongued and grooved bds, metallic shingles, paper, tile, or indeed anything that sheaths or encloses. A specification is not complete when it calls for sheathing unless it gives the kind. Whether specified or not all sheeting, Oregon fir included, is surfaced 1 side, but 1 side only.

SHINGLES:—There are 250 dimension shingles 4″ wide in a bunch; in common, there are enough of varying widths to cover the same surface. The thinning process has gone so far with them too that architects now specify that the thickness of 5 at butts shall not be less than 2″. The thinner shingles—6 to 2—are also narrower and require more to the sq.

LATH:—A bundle contains 50 pcs 4 ft long which suit joists at either 16 or 12″ centers. A shorter length—32—which does not suit 12″ centers is now on the market.

FINISH:—Unlike joists and dimension lumber finish comes within a trifle of the thickness; and the rough size is never taken when making out a bill. All good finish comes surfaced on 2 sides so that it is not necessary to specify surfacing. A cheaper kind is S1S only; but when wanted, it must be specially mentioned.

By referring back to the table it will be seen that the thickness is marked 13-16, 1 3-32 and 1 11-32. Contractors never use these sizes, but ⅞, 1⅛, 1¼, 1⅜, 1½, 1¾, and 2″. for the various kinds. It is better to keep to the common usage which is understood by all who handle lumber. One sometimes sees ⅞″ finish specified in 3 or 4 different ways—¾, 13-16, ⅞ and 1″. It is not safe to use ¾ for ⅞, as there is a thin finish that is occasionally seen on the market.

White pine is graded here as No. 1, 2, and 3; Chicago grades are A, B, and C. The price increases with the thickness.

The longest length of finish is 16 ft; special lengths are seldom seen as standard sizes can easily be joined.

Stock boards, which are cheaper than yp finish, are used for shelving. They are S2S, and never more than 12″ wide.

So far as the lumber-yard is concerned, then, this principle is clear: all sawing and surfacing are done inside of the specified size. Even down to furring strips this holds good; for they come 13-16x1¾ instead of 1x2.

But the width on a drawing or order is preserved at the planing mill when finish is billed. Corner-bds come to the exact size, and so does all such work when both edges are exposed. But a frieze, or plancher may be a trifle narrow as the bed molding covers the joint. With corner-bds, belt-courses, etc, it is better to give the exact width, but with ridges, cornice lumber, etc, to send the boards and let the carpenter do the fitting. Sometimes a ridge may be better if put on ½ wider than shown on drawing, owing to spacing of shingles; and this is just one illustration.

Lumber or timber is estimated in "board measure," or reduced to 1″ thick.

Most of the lumber-yards hand out measurement tables. To get the quantity in bm mult the section or end of the dimension lumber in inches and divide by 12, then mult the lf by the product. Suppose we have 100 pcs of 6″x6″x16′; 6 mult by 6 equals 36, which divided by 12 gives 3, which mult by 1,600 gives 4,800 ft in bm. If 2x4, the result would be 1,067, or ⅔ of the lf, for 8 is ⅔ of 12. If 2x10, 2,667, for 20 div by 12 equals 1⅔. A timber 14x16x24 has 444 ft bm, for 14 mult by 16 and div by 12 equals 18⅔, which mult by length is 444. The disadvantage of some tables is that each piece is figured by itself without fractions, and when many are required with a fractional ending there is apt to be a slip, while by reducing to lf the fraction can come only once. Thus a 2x8x16 is sometimes listed at 21 ft bm; it really contains 21⅓ ft; and if this figure were used for 100 ps the total would be 33⅓ ft more.

Flooring, ceiling, siding, shiplap, etc, are taken at standard width, and everything less than 1″ thick is counted as 1″. But the price per 1,000 sometimes differs. This rule applies to finish also—½″ thick counts as 1″. A flooring board 16 ft long by 4″, contains ⅓ of length in bm; and so for any width the same rule applies: 5″ would contain 5-12 of length, but unless for some special reason odd sizes are counted even.

Wp floor'g is graded No. 1, 2, 3, 4, or A, B, C, D. The best quality of yp floor'g is variously known as rift-sawed, quarter-sawed, vertical-grain, straight-grain. There are 3 grades of this flooring,—A, B and C. The angle of the grain must not be more than 45° from the vertical; if more angle is shown the floor'g is classed as flat-grain. Flat-grain is also classed as A, B and C; and below are No. 1 and 2 fence.

Yp ceiling is graded as A, B, No. 1 and 2 common.

Yp drop siding, A. B, No. 1 common. Bevel siding the same.

Yp partition: A, B, and No. 1 common.

Yp casing and base, A and B; window and door-jambs the same.

Yp common boards, shiplap and barn siding; No. 1, 2, 3, common; fencing the same. Yp finishing is graded 1st, 2nd, 3rd, clear.

Most people would naturally look upon No. 1 as being the best of its kind, but it is only the best common. A, B, and sometimes C, come

before this grade. There have been quarrels enough over grading, but it would still seem that either the alphabet or figures might be chosen and grades based accordingly with less chance of confusion.

MILLWORK:—It is not always an evidence of genius to change from a stock pattern to something new. It is not without reason that mill books have as an opening sentence, "It is economy to conform to regular sizes and styles as much as possible."

One mill book charges everything less than 100 ft as 100 for changing machine for odd work; another 60c extra for the same work; and 10% extra for all moldings if less than 200 ft are taken.

It is sometimes necessary to mark the size of a molding on a drawing so that it may be examined and criticized; but not on a bill of material; take the advice of the mill man and order by number. The molding book is universal. Nearly 500 pcs are listed. Sash, doors, blocks, gable ends, porch posts,—everything is listed by number.

Fine flooring is usually supplied by the millman. Maple and other hardwood floors have to be watched, as 2 to 16 ft lengths are standard. Some architects specify long lengths, but this means an increase in price. There is a brand sold at only 9″ to 20″ long. It means a spoiled floor.

No. 1, or clear maple, is the standard; and color must not be considered. Strictly clear is from $10 to $15 per 1,000 more. No. 1, 4 to 16 ft, and trimmed with matched ends to ft and half ft. Proportion of 4 to 5½ ft long may be 10%.

No. 2, small knots, sound, 2 to 16.

No. 3, or factory, is inferior with some waste in cutting.

The standard width of 2″ is 1⅜ face; 2¾, 2 face; 3, 2½ face; 4, 3¼. Maple, No. 1 grade is made from ⅜ to 1¾ thick; but ⅜, ½, ⅝ flg is made in 1⅜ and 2 face only if maple; but ½ and ⅝ in other woods cometimes run to 2¼. The same lengths and widths apply to maple, oak, birch, cherry, and walnut.

SASH:—Sash and brick are plural in the U. S. This for the information of some transatlantic cousins.

The listed thicknesses are 1⅛, 1⅜, and 1¾: the actual are only a trifle less. Stables, coal-sheds, and such buildings are fitted with 1⅛; and they are also used for storm-sash. The 1⅜ are for cottages with 4″ studding; and most of them have that width.

"Doors, blinds, and sash are often ordered 1¼, 1½ and 2″ thick. Do not use these terms, as it only delays orders." An extra price is charged for thicknesses not listed.

The width of a window is of course regulated by the glass. Add for 2 lt window 4⅛″. This gives the size of the frame, as ⅛″ is allowed for play, and the wood is 2″ beyond the glass on each side. All 2-lt standard windows are 6″ longer than glass, and this also gives frame. With sash and doors, the order is width, length, thickness. Thus a specimen order might be, "10 win, 2 lt, 24x24x1⅜, SS,—" or DS as the thickness of glass, single- or double-strength. It is safer to specify check-rail if wanted. The size of the frame would be 2′ 4⅛″x4′ 6″.

The length of a 4-lt win is the same; but 5″ wood instead of 4, as cen-

ter-bar is $\frac{7}{8}$ thick. The frame for a 15x24 is 2′ 11″x4′ 6″. For an 8-lt window, 5″ of wood; but length is same, as cross-bars are not quite $\frac{1}{4}$ thick. An 8-lt, 10x12 frame is 2′ 1″x4′ 6″.

For 12-lt window cross-bars are $\frac{1}{4}$. Frame for 10x12 is 2 $10\frac{1}{2}$x4′ 6″.

It is sometimes desirable to use wider sills and thicker cross-bars, and the frame has to be increased to suit. Store sash have $3\frac{1}{2}$ stiles and $4\frac{1}{2}$ bottom -rail.

DOORS:—Standard thicknesses are $1\frac{1}{8}$, $1\frac{3}{8}$, $1\frac{3}{4}$. There are doors 13-16 thick, but they are of small value. The mill book gives a long list of standard sizes, and it would be well if they were always followed. Doors may be sent open or glazed as ordered. Mill glazing is generally cheaper.

BLINDS:—They are listed at $1\frac{1}{8}$, and $1\frac{3}{8}$ thick, both for outside and inside. The thicker ones are seldom seen.

STAIR WORK:—Balusters, $1\frac{3}{4}$; newels, 5 and 6″. But there is endless variety.

WAINSCOTING:—Thickness is usually $1\frac{1}{8}$; but $\frac{7}{8}$ is also made.

CHAPTER XXII

STANDARD 10-STALL 79.5-, 85-, AND 90-FT ENGINE-HOUSES ALSO A 50-STALL RECTANGULAR ENGINE-HOUSE

The standard engine-house is now being increased from 80 to 85 and 90 ft on main lines of railroad.

Standards naturally differ on different roads, but a fair average may be obtained from the following figures. As the 85- and 90-ft houses are of recent growth the estimate will be of value, but a few remarks are necessary to remind the reader that all kinds of changes are possible; and that local conditions might seriously affect the total. Length is over walls—not inside:

EXCAVATION:—The allowance is about 4′ below base of rail. Instead of excavation a fill might be necessary, or the natural surface might be several ft too high, perhaps adding hundreds of dollars to the cost. Then the pits might not require to be excavated in the center, but only for footings run down on each side in the firm soil.

CONCRETE OR RUBBLE:—Quantity depends upon the section used, and price upon locality. Footings are estimated 3′ wide. The bottom of pits might be of same thickness full length; or might have to be level on base and the slope of solid concrete. There is more labor required on pits and angles than on a straight wall. Am. Portland is estimated.

CUT STONE:—Water-table and sills are estimated at 8x8; for ordinary work 5x7 is used. Door-sills are est stone. Water-table might be concrete. Window-caps might be stone, and not old rail to be cut and set. Pier-blocks might be iron and not stone as below. A local stone might be supplied for \$1.20 per cf instead of \$1.40 as estimated. Unloading and setting, 15%, total, \$1.61. Range-work might have to be added.

BRICK:—Walls ought to be 17″, but in a fit of economy they might be cut to 13″; and hight might be changed. Size and number of openings; price of brick, pilasters, and cornices are all subject to change. Pressed brick might be used. Number is given in wall measure.

LUMBER:—This material is of various prices in different sections of the country; millwork varies by 20 to 30% even in the same section; carpenters are paid 30c in one place and 45 in another; and paving might be used in one house and left out in the next. An extra line of inside posts is used on the 90′ house.

There is no painting ets'd on brick, posts or ceiling. Smoke-jacks and ventilators are of wood—add $230 if steel is wanted.

Pits are deducted from paving; and length is increased to correspond with house.

Piping is for air, steam and water.

There is no gutter.

Net prices are used.

10 STALLS.

DETAILED ESTIMATE OF COST WITHOUT PROFIT

	Rate	79′-6″	85′	90′	79′-6″	85′	90′
Excavation	.30	1,020	1,090	1,170	$306.00	$327.00	$351.00
Concrete	5.50	682	730	785	3,751.00	4,015.00	4,317.50
Cut stone, set	1.61	341	349	381	549.00	561.90	613.40
Brickwork	11.00	212,600	226,000	238,000	2,338.60	2,486.00	2,618.00
Coping and pit-pipe	....	....	....	....	70.00	73.00	76.00
Old rail	....	....	....	....	175.00	175.00	175.00
Lumber	18.00	100,300	112,500	124,500	1,805.40	2,025.00	2,241.00
Millwork and glass	....	....	....	....	925.00	925.00	925.00
Carp labor	....	....	....	....	920.00	1,000.00	1,100.00
Gravel roof	4.50	140	151	162	630.00	679.50	729.00
Hardware	....	....	....	....	315.00	320.00	325.00
Painting	....	....	....	....	250.00	250.00	250.00
Smoke-jacks and ventilators	....	....	....	....	550.00	550.00	550.00
Track	.60	800	850	900	480.00	510.00	540.00
Piping	....	....	....	....	1,600.00	1,650.00	1,700.00
Paving	1.25	952	1,040	1,111	1,190.00	1,300.00	1,388.75
Galv iron	....	....	....	....	37.00	40.00	43.00
Total	....	....	....	....	$15,892.00	$16,887.40	$17,942.65

Material, 72 to 74 per cent. of total.
Labor, 28 to 26 per cent. of total.

If drop-pit is used allow $400 extra.

The average contractor would take such buildings for a profit of 5%, or about $800 additional; and out of this pay insurance, etc. If thrown open to bidding a cut of 10 to 15% might be made—and the usual crop of accidents, liens, lawsuits, etc spring up to vex the earth.

On the basis of 17 used on No. 2 (See Chap 5), 160,600, 170,700, and 179,800 actual brick are required; at 17½ to the cf, as with very small brick, 165,350, 175,800, 185,100; at 15½, for very large, 146,500, 155,700, and 164,000, or a difference of about 20,000. On the 16¼ basis used on No. 8, 153,550, 163,200, 171,900 for the 3 different houses, in round numbers, with brick clear to grade.

INSIDE STALLS

For inside stalls on same basis:

Excavation.....	95 cy	103	113	$28.50	$30.90	$33.90
Concrete.......	61	68	75	335.50	374.00	412.50
Cut stone	25	25	28	40.25	40.25	45.10
Brick..........	11,500	11,800	12,100	126.50	129.80	133.10
Old rail.......				12.00	12.00	12.00
Lumber........	10,200	10,700	11,500	183.60	192.60	207.00
Millwork.......				80.00	80.00	80.00
Carp labor.....				87.00	95.00	105.00
Gravel roof.....				63.00	67.95	72.90
Hardware......				30.00	30.00	30.00
Painting.......				20.00	20.00	20.00
Smoke-jack&vent				55.00	55.00	55.00
Track.........				48.00	51.00	54.00
Piping.........				160.00	165.00	170.00
Paving........				119.00	130.00	138.85
Total.......				$1,388.35	$1,473.50	$1,569.35

Add whatever profit is considered possible to total cost price.

For 8 inside stalls.	$11,106.80	$11,788.00	$12,554.80
For 2 outside stalls.	4,785.20	5,099.40	5,387.85
	$15,892.00	$16,887.40	$17,942.65
For 1 outside stall.	$2,392.60	$2,549.70	$2,693.95
For 1 inside stall.	1,388.35	1,473.50	1,569.35
Difference.	$1,004.25	$1,076.20	$1,124.60

At 17 brick to the cf an inside stall requires 8,700, 8,900, 9,150.

For the excavation of a standard pit allow 34 cf to each lf full length of pit, and add 3 cy for the deep end.

For concrete or rubble deduct the 2 ends, or 6′ 2″, from extreme length, and allow 184 cf for them; then multiply each lf of straight pit by 21.07, and add 184 to the result for the total in cf.

If piles are used, staggered about 4-ft centers, allow for walls and piers, 64 for the 2 end-stalls, and 14 for each inside stall. For each pit, 36. At $5 per pile, $268 per stall on a 90-ft, 10-stall house.

If concrete is used instead of timbers, allow 2.5 cf to each lf of pit, a total of 23.57 cf.

When finishing the foregoing estimates I saw a plan of a rectangular engine-house in "The Engineering News" of Mar. 3, 1904. It is rather an interesting substitute for the ordinary roundhouse, and as the cost was not given among the other advantages or drawbacks I made an estimate, as nearly as possible without working plans, so that a comparison might be had with the 85-ft radial house. To correspond with that the size of Mr. Nichols' plan was changed to 85 ft over walls instead of inside. The depth of footings and hight of walls are the same; roof is est at ½″ rise to the ft; prices are same. Steel lintels are put over triple openings, and that increases the cost; but there would not be sufficient light with 2 ordinary windows. Skylight and lantern are extra, and none too large.

The cost of a transfer pit recently erected and supplied with table by Mr. Nichols was $21 per lf; with end walls not necessary in "Eng News" plan, and with 1 wall fewer in center the cost is $18 on same sections and depth. Pit is given separately, although enclosing walls necessarily go with building. Paving is not figured in pit. Traveling crane, drop-pit, etc, are not estd, but both bldgs kept on same basis.

Summary of "Eng News" plan of a 50-stall, 85-ft, rectangular engine-house, 240′x471′:

Excavation	$ 1,590	Skylight	$ 4,300
Concrete	18,293	Hardware and Lantern Gearing	1,200
Cut Stone	2,700	Painting	1,050
Brickwork	6,636	Smoke-jacks and V's	2,750
Steel Lintels	2,590	Track	2,326
Lumber	12,384	Piping	7,500
Millwork	4,000	Paving	6,875
Carpenter Labor	6,000	Flashing	200
Gravel Roof	4,644		
			$85,038

Summary of transfer pit:

Excavation	$ 1,800	
Concrete	5,462	
Rail, bolts, and clips	908	
Transfer Table	6,600	
Side coping timber	240	
		$15,010
		$100,048

Summary of a 50-stall, 85 ft, radial engine-house:

2 Outside stalls	$ 5,100	
48 Inside stalls	70,728	
1 Turntable	5,125	
50 New frogs	1,000	
5000′ Track bet table and doors	4,000	
		$85,953
		$14,095

The roundhouse is 16% cheaper than the rectangular plan. The plain L. S. D., "dollars and cents," argument is against a change unless other reasons than cost carry the day. And Mr. Nichols admits that a turntable is still necessary in the yard. If the transfer table is cut out the walls can be materially shortened and the cost much reduced, but a new method of working is required.

Fire walls seem to be obsolete now. They are not estd on either plan. For a radial house, if used, allow $800 to $900 ea complete.

In these estimates the pipes are in place ready for steam-heating: if the hot-blast system is used instead, the supply has to be brought to the blower from which distribution is made. The cost is about the same as with the pipe system. Of 6 engine-houses in different parts of the country heated by the blast system the average of the work was $191 per stall; the price ranged from $165 to $245. If the highest figure is eliminated the average is $181.

TURNTABLES

For a 72′ table allow $2,300 FOB Chicago—wt, 31 tons; 1,000 cy excavation; 227 cy concrete or rubble; 60 cy gravel for slope; 21 piles if any are used; $200 for ties, bolts, coping and labor; $70 for 70-lb pit rail; $30 for catchbasin; and $300 for bending rail, unloading and setting table, a total without the piles of $4,628.50, with excavation at 30c, concrete at $5.50, and gravel at $3. Piles, freight and percentage to be added if required.

For a 75′ table allow $2,650, Chicago,—wt, 38 tons; 1,070 cy excavation; 236 cy concrete; 66 cy gravel; 21 piles; $225 for ties, bolts, etc; $73 for pit rail; $30 for catchbasin; and $330 for unloading, bending and setting, a total of $5,125. Add piles, etc, if necessary same as on 72′ table. The 66′ table is now out of date.

CHAPTER XXIII.

COST OF BUILDINGS PER SQ AND CU FT.

Only approx estimates can be taken from the following figures. Local conditions affect the result so much that one building might cost 25% more than another of the same size, in the same section of the country, and at the same rate for labor and material. In the one case the ground might be 12′ below grade, and in the other as much above; piling might be required in the one, and rock blasting in the other. Sometimes 25% of the total cost of a building is expended before foundations are up to grade. But for average buildings approx figures are useful.

SCHOOLHOUSES:—No. 12, built about 15 years ago, of plain design, $75 per scholar; 8 rooms, 400 seats; brick and wood construction. Another Omaha school now going up (1904) of the same size costs $115. Material and labor are higher, and the design is more ornate. In the country the cost might be reduced from 10 to 15%.

An addition to the Omaha high school, finished in 1902, strictly fireproofed, Bedford stone on 3 fronts, 16c per cf. The complete cost was about $190,000. With 4 stone fronts the cost might have run to 18c.

FIRE ENGINE-HOUSES:—About 12 years ago an Omaha house was built for 6c per cf; in 1904 the city is paying $4.25 per sq ft for one in course of construction; and 11c per cf for another.

WAREHOUSES:—3 of the largest and latest in the city cost from 6½ to 8c per cf. They are of mill construction, and from 5 to 6 stories high. Bids on 2 others ran under 7c. One of cheaper construction cost 5½c. One story, 12′ high, no basement, $1.80 per sq ft.

STORES AND FLATS:—I have put in bids for a large number of these buildings, but have let the sizes slip. A figure of 9 to 12c seems about right. For flats alone 9 to 14c according to the finish and locality.

OFFICE BUILDINGS:—About a dozen years ago several fine Chicago office buildings, fire-proofed, were erected for 20 to 22c per cf, but this is too low a figure now: 30c is about right. Mr. Kidder gives a list of 20 fire-proof bldgs running from 25 to 63c with an average of 40. For wood construction, 18 to 20c.

No. 3 taken at the level of the first floor cost complete $20 per sq ft. It is of wood construction, but fire-proofed with tile throughout. In Chap 7 the cost of 16 U. S. post-offices is given.

LIBRARIES:—Allow for fire-proofed buildings 30 to 45c per cu ft.

Y. M. C. A.'s:—From 12 to 24c per cf.

HOSPITALS:—No. 2, strictly fire-proofed, 14c per cf; No. 1, of wood construction, about half as much; but both are only shells with practically no partitions. For fire-proofed buildings fully equipped, 20 to 35c.

HOTELS:—From 18c for brick with ordinary construction to 50c per cf for fire-proof work. Lunch-counters, oak, circle ends, $3.30 per lf.

RESIDENCES:—Anywhere from 10c to $5 per cf. One of the best houses in Omaha cost from 20c to 22c, brick; a better one of stone, about 37c, but neither is fire-proofed. Chicago price for city dwellings, 17 to 20c. For frame houses without modern improvements, with shingle roofs, $300 to $350 per room; with modern imps, and part or all hardwood finish, slate roofs, $450 to $500. Brick houses, 8 to 10 rooms, 10c.

STABLES:—From 10 to 20c per cf.

CHIMNEY STACKS:—The cheapest one I know of is square, 150′ high, and cost without profit, $35 per ft, foundation included. One of large radial brick, 175 ft, 10 to 7 ft core, $45; another 200, 11 to 9 core, $55; both circular, but foundations are not included. A stack of radial brick 100′x5′, $2,200; 125x6, $3,200, without foundations—but distance from yard, etc, affects price.

Self-sustaining steel stacks 7′ diam, 150 ft high, without foundation, $29; 9′ and 200′, $33 set. For small guyed stacks allow per ft at factory as follows:

	24″	30″	36″	42″	48″
No. 14 iron	$1.35	$1.71	$2.07	$2.43	$2.79
No. 12 iron	1.84	2.32	2.80	3.28	3.76
No. 10 iron	2.38	2.92	3.46	4.00	4.54

Allow setting extra at $15 to $40. Wire rope, ⅜″, 3c per ft; ¼″, 1½c. For sizes not given allow 4 to 4½c per lb at factory.

RAILROAD BUILDINGS

See Chap 22 for Engine-houses.

	Sq ft
FRAME STATIONS with living rooms, pile foundations	$1.30

FRAME STATIONS with brick or stone foundations........... 1.55
PASSENGER- AND FREIGHT-DEPOTS, frame, pile foundations 1.15
PASSENGER- AND FREIGHT-DEPOTS, brick or stone foundations.................................. $1.40 to 2.00

If not a standard the cost might be increased from 10 to 100% more.

PASSENGER-STATIONS, MODERN:—Brick, stone, slate roof, hardwood finish, average of 6 designs built, $3.60; running from $3.41 to $3.77. One of larger and better design cost $4.20.

LAVATORIES:—Separate 1-story brick buildings, with the finest plumbing, ex-metal lockers, etc, $3.70 to $4.25 per sq ft. The average of 3 is $3.75. Inside of main buildings, $3. Approx, 12c per sq ft of complete ground floor area of main buildings. Ex-metal lockers, $6 each.

OIL-HOUSES AND PLATFORMS:—From $2 to $2.75. Platforms are about 50% more than buildings proper. Concrete and brick.

But here it may be worth while to say that to get good results from either the sq or cf basis it is necessary to have a building of reasonable size. An oil-house might be 200 ft long, or it might be 20, but in both cases 2 gables are required. The cost is distributed over a large area in the one case, and a small in the other.

STOREHOUSES:—Of the heaviest construction, 2 stories, no basement concrete, brick, steel, $3.80 sq ft. Without electric elevators, fireproof shutters, etc, $3.50. Deduct 25c if platforms are not required. A large storehouse, 2 stories and basement, was built for $3.05. But I know of another bldg of the same nature and hight with more and better outside and inside finish, plumbing, elevators, electric wiring, etc, which ran to $5.25, or 13c per cf. For shelving and uprights allow about 2¼ ft for each sq ft of total net floor space. Piling, if required, 13c sq ft of ground floor.

But the Rock Island storehouse at Moline, Ill., is given in the "Railway Age" of Feb. 26, '04, at $1.50 per sq ft. It is a 3-story brick, wood construction inside, and the price is based on the ground area only. The total area is 5 times as large as that of the new Union Pacific storehouse, Omaha. The size is 500'x100'; and 3.6c per cf matches the price given on the sq ft basis. It seems too low a figure; but the cost is not official.

The storehouse for the Seaboard Air line at Portsmouth, Va., cost $1.17 per sq ft on ground floor; but it is brick only to the window sill, and unsheeted frame above covered with galv iron. It is 2 stories and a basement.

The frame building described on page 19 is a kind of a storehouse. It is sheeted inside on first story, and has shelving, refrigerator, and office in one end. Without any foundation, $1.16 per sq ft.

MACHINE- AND ERECTING-SHOPS:—With areas of 50,000 to 100,000 sq ft the average of 5 built was $1.80. The figures ran from $1.27 to $2.40. The Rock Island shop 860 ft long, is given in "The Railway Age" of Feb. 26, at $1.50. But cost of shops is heavily affected by foundations, and by style of construction. Foundations to grade may easily cost 25% of the total; and the lean-to style of the R. I. shop

is far cheaper than if the outside walls were carried to level of main roof. Everything is ready for cranes but none included. Piling if required, 14c per sq ft of total area. The highest price per cf, heated, should not exceed 5.5c.

BOILER-SHOPS:—From $1.30 to $1.85 with average of $1.56 on 4 large ones built. Piling about 9c if required.

POWER-HOUSES:—About $2.75 to $3.50.

BLACKSMITH SHOPS:—The average of 4 of large area in widely separated parts of the country was $1.32 per sq ft. The figures ran from $1.15 to $1.70. Piling if required, 6 to 7c.

WOODWORKING:—On 3 built, $1 to $1.40.

CAR- AND COACH-SHOPS:—From $1.25 to $2 on several.

PAINT- AND FREIGHT-:—From $1.25 to $2 on several.

DRY-KILN:—75c to $1.30.

COAL- AND IRON-SHEDS:—$1.20 to $1.50.

All figures given are for best construction of concrete, brick and steel.

The Seaboard Coach-shop, brick to window-sills, studs unsheeted, covered with galv iron, 68c; planing-mill of same style, $1.29.

ICE-HOUSES:—For 50-ton, $1.50; 100, $1.65.

BUNK-HOUSES:—From $1.05 on pile foundations to $1.25 for stone or brick.

The following useful figures are taken from the Railroad Gazette of July 1, 1904. They were compiled by Master Mechanics:

COST OF LOCOMOTIVE REPAIR SHOPS.

"In selecting units on which to base cost figures the square foot and the cubic foot have generally been used for buildings; in power plants the engine horse-power, boiler horse-power and generator kilowatts have also been used; in roundhouses the stall has been taken as the proper unit. In computing the square feet of buildings, the outside dimensions have been used (giving the ground area covered); in computing the cubic feet of buildings, the average external height has been taken (giving the total volume occupied).

In the figures which follow, the different items are identified by reference numbers only, with such explanatory notes added as will aid in interpreting the unit prices; shops built prior to 1895 are designated as "old", those built since 1895, as "modern"; in a few cases the notes are based on uncertain information and are followed by an interrogation mark (?).

It is believed that in most cases the cost of a proposed shop will be asked for as soon as the layout plan has been completed, and that the following is the best basis for making an estimate: List up all the buildings, with their ground area in square feet, all the miscellaneous structures, either on the square foot, the lineal foot, or the unit basis (as may appear best), all the track on the lineal foot basis, the turnouts on the unit basis, etc.; assign a unit price to each item, as determined by the special local conditions, carry out the cost extensions and totalize; to the total thus obtained add a percentage to cover incidentals and items not shown by the layout plan; this percentage

may vary from a minimum of ten per cent to a maximum of 25 per cent, according to the completeness of the layout plan and the degree of confidence which may be felt in the unit prices assumed; the grand total should represent the approximate cost of the plant, exclusive of the cost of land and grading, which should be estimated separately, these two items not being susceptible of reduction to a unit basis. If the buildings have been designed in detail their cost may be checked upon the cubic foot basis.

The report is signed by R. H. Soule, Chairman; L. R. Pomeroy, T. H. Curtis, S. F. Prince, Jr., A. E. Manchester."

POWER PLANTS—TOTAL COST.

Item	Cost per Engine H. P.	Cost per Generator K. W.	Cost per Sq. Ft.	Cost per Cu; Ft.	Notes.
131	131.33	219.00	11.40	.40	Far West, modern; a substantial, effective plant devoid of ornamentation or refinement; coal dumped from trestle and shoveled, ashes shoveled.
132	140.27	210.00	7.00	.18	Middle West, modern; building has considerable ornamentation inside and out, but the equipment auxiliaries are simple; overhead crane in engine room.
133	115.00	167.00	12.20	.28	East, modern; building has considerable ornamentation alternating current apparatus inside and out; principally with auxiliary direct current equipment.
134	185.06	278.00	11.50	.36	Middle West, modern; includes (besides boilers, engine generators, and air compressors), induced draft apparatus, coal and ash handling apparatus, hydraulic plant, etc.
135	129.28	210.60	14.62	.33	Middle West, modern; a very complete plant both mechanically and architecturally.
136	123.00	191.00	14.30	.36	Middle West, modern; large enough to allow for a one-third increase in capacity of plant.

Item	Cost per Engine H. P.	Cost per Generator K. W.	Cost per Sq. Ft.	Cost per Cu. Ft.	Notes.
137	129.00	225.00	10.40	.58	East, modern; fireproof construction throughout.
138	90.90	151.50	10.40	.24	West, modern; a simple but effective plant limited to direct current, no coal or ash handling apparatus.
139	128.60	211.00	10.55	.31	Middle West, modern; condensing equipment.

ERECTING AND MACHINE SHOPS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
140	3.50	1.08	.71	5.34	.076	.115
141	1.03	2.49	.187	3.70	.034	.123
142	.706	1.78	....	....	.029	....
143	1.67	2.05	.086	3.79	.051	.118
144	2.43	.81	....	....	.051	....
145	1.65	2.69	....	....	.041	....
146	1.80	1.65	....	....	.046	....
147	1.82	....	....	....	.050	....
148	3.08	1.65	....	....	.073	....

140. East, modern; brick and steel transverse shop, erecting shop has both heavy and light cranes; machine shop has crane service throughout, saw tooth roof.

141. Middle West, old; brick and wood, transverse shop in two parts, one part one story with slate roof, the other part two stories with gravel roof.

142. Middle West, old; stone and wood, transverse shop, gravel roof supported by posts.

143. Middle West, old; brick with wood and iron roof trussing and shingle roof, longitudinal shop, machine shop on one side, traveling cranes in erecting shop.

144. Middle West, modern; brick and steel, transverse shop, high for two-thirds of width with heavy crane, the remaining one-third being low, with saw tooth roof.

145. Middle West, three-fourths old, one-fourth new, brick and steel, transverse shop, new part two stories; no traveling cranes.

146. Pacific Northwest, modern; brick and steel, overhead crane.

147. Pacific Southwest, modern; brick and steel, overhead crane.

148. Far West, modern; brick and steel, overhead crane.

MACHINE SHOP.

Item	Cost per Sq. Ft. of Ground Area. Building Only	Tools	Misc. Eqpt.	Total	Cost per Cu. Ft. Building Only	Total
157	.952	....	....	....	.038	....

157. Middle West, old; brick and wood, gravel roof supported by posts.

BOILER AND TANK SHOPS.

Item	Cost per Sq. Ft. of Ground Area. Building Only	Tools	Misc. Eqpt.	Total	Cost per Cu. Ft. Building Only	Total
158	2.98	.72	.84	4.54	.083	.127
159	1.58	.40	....	....	.049	....
160	.84	.94	.076	1.87	.033	.075
161	1.66	.48	.083	2.24	.059	.080
162	.99	....	....	....	.025	....
163	1.53	.96	....	....	.095	....

158. East, modern; brick and steel, cranes cover entire floor, saw tooth roof.

159. Middle West, modern; brick and steel, one-half width high for crane service, the other half lower and without crane.

160. Middle West, old; brick and wood with slate roof.

161. Middle West, old; brick and wood, shingle roof, gallery along one side, cranes over part of floor space.

162. Pacific Southwest, modern; brick and steel, overhead crane, smith shop in one end.

163. Middle West, two-thirds old, one-third new; brick and wood, new part two stories, no overhead cranes. (?)

SMITH SHOPS.

Item	Cost per Sq. Ft. of Ground Area. Building Only	Tools	Misc. Eqpt.	Total	Cost per Cu. Ft. Building Only	Total
164	....	.734	.110	....	....	....
165	2.63	.982	.171	3.78	.080	.115
166	1.79	.144	....	....	.049	....
167	.432	2.26	.086	2.77	.019	.126
168	1.06	1.09	.050	2.22	.035	.074
169	2.25	....	....	....	....	....
170	1.43	.665	.435	....	.042	....
171	1.50	....	....	....	....	....
172	2.37	1.96	.348	4.68	.052	.104
173	1.21	....	....	....	.041	.055
174	1.38	....	....	....	....	....
175	.91	.60	....	....	.031	....

164. Middle West, old.

165. East, modern; brick and steel, high and light, thoroughly equipped.

166. Middle West, modern; brick and steel, one hundred feet wide, hip roof without posts.

167. Middle West, old; brick and wood with slate roof.

168. Middle West, old; brick and wood, shingle roof.

169. Southeast, modern; brick and steel, unusually high (thirty-three feet from floor to lower cord of roof truss). (These figures should be used with caution, as they are not official, but were taken from a published statement.)

170. Middle West, modern; brick and steel.

171. Middle West, modern; brick and steel, tile and gravel roof.

172. Middle West, modern; brick and steel, brass foundry and car machine shop under same roof, equipment very complete.

173. East, modern; concrete and steel, 80-foot span, no posts.

174. Northeast, modern; brick and wood, 60-foot span, no posts, simple construction.

175. Middle West, two-thirds old, one-third new; brick and wood(?).

IRON FOUNDRY.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
176	3.18	....	....	....	....	....

176. Brick and steel, modern; U. S. Navy Yard, Bremerton, Wash.

PATTERN AND UPHOLSTERY SHOP.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
178	.857	....	.131	.988	.043	.050

178. Middle West, old; modern building, two stories.

PASSENGER CAR REPAIR SHOPS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
179	1.24	....	.016	1.25	.042	.043
180	1.20	....	....	....	....	....
181	2.64	.044	.096	2.78	.099	.105
182	1.34	....	.015	1.35	.056	.057
183	.68	.003	.057	.74	.026	.028
184	.83	....	....	....	.029	....

179. Middle West, modern; longitudinal shop, brick and wood.

180. Southeast, modern; transverse shop, brick and wood, has upholstery and cabinet shops under same roof. (These figures should

be used with caution, as they are not official, but were taken from a published statement.)

181. Middle West, modern; transverse shop, brick and steel, includes upholstery and trimming shop and hot-air heating.

182. East, modern; transverse shop, brick and steel with cement foundation, saw tooth, wooden roof.

183. Southeast, modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above, gravel roof, granolithic floor, used also for painting and varnishing. (Identical with Passenger Car Paint Shop No. 193.)

184. Middle West, old; brick and wood (?).

PASSENGER CAR PAINT SHOPS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
185	1.24	....	.044	1.24	.04	.04
186	1.94	.055	.092	2.09	.072	.078
187	1.02	....	....	....	.033	....
188	1.20	....	...	....	....	....
189	1.01	....	.039	1.05	.035	.036
190	.35	....	....	....	....	....
191	2.36	.009	.056	2.43	.081	.084
192	1.13	....	.009	1.14	.051	.052
193	.68	.003	.057	.74	.026	.028
194	.89	....	....	....	.032	....

185. Middle West, modern; longitudinal shop, brick and wood.

186. East, modern; longitudinal shop, brick and steel, saw tooth roof, hot-air heating.

187. Pacific Southwest, modern; transverse shop, brick and steel.

188. Southeast, modern; transverse shop, brick and wood, has varnish room and pipe shop under same roof. (These figures should be used with caution, as they are not official, but were taken from a published statement.)

189. Northeast, modern; longitudinal shop, brick and steel, includes small paint, varnish and boiler rooms at one end.

190. South, old; wooden structure.

191. Middle West, modern; transverse shop, brick and steel, includes cleaning room, varnish room and hot-air heating.

192. East, modern; transverse shop, brick and steel with cement foundations, saw tooth, wooden roof.

193. Southeast, modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above; gravel roof, granolithic floor, used also for coach repairs. (Identical with Passenger Car Repair Shop No. 183.)

194. Middle West, old; brick and wood (?).

FREIGHT CAR REPAIR SHOPS.

	Cost per Sq. Ft. of ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
195	.40	....	.016	.415	.022	.023
196	2.12	.123	.047	2.29	.075	.080
197	.29	....	....	.29	.015	.015

195. Middle West, old; wooden building, longitudinal, entirely enclosed.

196. Middle West, modern; brick and steel, longitudinal, includes cabinet shop and hot-air heating.

197. Middle West, old; large shop, longitudinal construction not known, but probably wood with partly open sides.

CAR SMITH AND CAR MACHINE SHOPS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
199	.77	1.06	....	....	.028	....

199. Middle West, old; brick and wood (?).

WHEEL AND AXLE SHOP.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
200	4.03	2.16	.72	6.91	.16	.276

200. West, modern; brick and steel, for car work only.

CAR REPAIR SHOP AND PLANING MILL.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
201	.975	....	....	....	.031	....

201. Pacific Southwest, modern; brick and steel, has intermediate two-story section for sub-departments.

PLANING MILLS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
202	.487	.54	.010	1.04	.026	.056
203	1.15	1.18	.25	2.58	.045	.102
204	.76	1.21	.292	2.26	.033	.098
205	1.85	....	....	....	....	....
206	.37	....	....	....	....	....

207	2.54	1.44	.082	4.06	.095	.153
208	2.53	.558	....	....	.057	....
209	.39	.50	....	....	.014	....
210	.74	.485	.239	1.47	.037	.073

202. Middle West, old; wooden building, tools and equipment very light.

203. Southeast, modern; brick up to floor line, then corrugated galvanized iron on insulated wooden frame, basement and one story, gravel roof, mechanical power in annex, cabinet shop in wing.

204. Middle West, old; brick and wood, slate roof.

205. Southeast, modern; steel and brick. (These figures should be used with caution, as they are not official, but were taken from a published statement.)

206. South, old; wooden structure.

207. Middle West, modern; brick and steel, does not include cabinet shop, which is separate.

208. Middle West, old; brick and wood, includes pattern shop (?).

210. West, modern; wooden (?).

STOREHOUSES.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
211	1.142	....	.168	1.31	.044	.050
212	3.60	....	....	....	....	....
213	3.05	....	.67	3.72	.073	.089
214	2.40	....	....	2.72	.110	.124
215	2.00	....	....	....	.050	....

211. Southeast, modern; brick up to window sills, then corrugated galvanized iron on unsheathed wooden frame, two stories, gravel roof, platform, bins, shelves, etc., complete.

212. Southeast, modern; brick and steel, two stories and basement, extensive offices in one end on both floors. (These figures should be used with caution, as they are not official, but were taken from a published statement.)

213. Middle West, modern; brick and wood, three stories.

214. East, modern; concrete construction, one end two stories, upper floor used for offices.

215. Middle West, old; brick and wood, two stories (?).

OIL HOUSES.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
216	5.41	....	1.43	6.84	.208	.263
217	3.52	....	1.55	5.07	.196	.302
218	1.33	....	....	....	.089	....
219	2.15	....	1.34	3.49	.097	.159

216. Middle West, modern; brick and steel, basement and one story, full equipment of tanks, etc.

217. East, modern; concrete walls and roof, one story with deep basement.

219. West, modern; brick and steel, tile roof, two stories.

ROUNDHOUSES.

Item	Number of Stalls	Cost per stall. Building Only	Tools	Misc. Eqpt.	Total
220	18	1,388.88	......	......	....
221	46	1,155.00	......	......	....
222	10	2,400.00	......	......	....
223	10	1,757.70	......	......	2,090.00
224	30	....	......	......	1,500.00
225	13	1,040.00	......	......	....
226	8	2,750.00	......	......	....
227	7	1,033.00	......	......	....
228	33	....	......	......	2,200.00
229	..	....	......	......	1,845.00
230	44	1,998.00	133.00	328.00	2,459.00
231	30	4,150.00	......	......	....
232	25	1,950.00	......	......	2,455.00
233	48	2,480.00	......	......	....
234	25	1,719.00	......	......	....
235	18	1,011.00	......	......	....
236	23	1,065.00	......	......	....
237	44	1,740.00	......	......	....
238	40	1,875.00	87.50	787.50	2,750.00

220. Middle West, old; 63-foot span, brick and wood, slate roof, trussed (no posts).

221. Pacific Southwest, modern; 80-ft. span, brick and wood, roof supported by posts.

222. Far West, modern; part 75-ft. span, part 85-ft. span, brick and wood, gravel roof, supported by posts.

223. Far West, modern; 85-ft. span, brick and wood, gravel roof, supported by posts.

224. Middle West, old; 65-ft. span, brick and wood, gravel roof, supported by posts.

225. Middle West, old; 78-ft. span, brick and wood, gravel roof, supported by posts.

226. Middle West, modern; 89-ft. span, brick and wood, gravel roof, supported by posts.

227. Middle West, old; 80-ft. span, brick and wood, gravel roof, supported by posts.

228. East, modern; 81-ft. span, brick and steel, gravel roof, supported by flat truss (no posts), rolling steel doors, cost does not include heating equipment.

229. Northwest, modern; 84-ft. span, brick and wood, gravel roof supported by posts, cost does not include heating equipment.

230. Northeast, modern; 80-ft. span, brick and wood, gravel roof, supported by posts, annex with boilers, heating apparatus (hot air), and air compressor.

231. East, modern; 90-ft. span, brick and steel, slag roof, with crane runway covering outer half of span, has very heavy pile and stone foundation.

232. East, modern; 80-ft. span, concrete and wood, gravel roof, supported by posts.

233. Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.

234. Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.

235. Northeast, modern; 72-ft. span, brick and wood, gravel roof, supported by posts.

236. West, modern; 80-ft. span, brick and wood, gravel roof, supported by posts.

237. Middle West, part old, part modern; 70-ft. and 85-ft. spans, gravel roof, supported by posts (?).

LAVATORY.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
239	....	....	....	2.55	....	....

239. Middle West, modern; average of three large lavatories (including water closets, urinals, wash room and locker rooms); buildings of concrete and brick with tile roofs on wooden trusses; cement floors, complete with contents, ready to use.

OFFICE BUILDINGS.

	Cost per Sq. Ft. of Ground Area.				Cost per Cu. Ft.	
Item	Building Only	Tools	Misc. Eqpt.	Total	Building Only	Total
240	.306	....	....	....	.030	....
241	8.01	.557	.295	8.86	.167	.187
242	1.04	....	....	....	.034	....

240. Middle West, old; frame building with brick foundation, includes M. M. store department, steam heat.

241. Middle West, modern; brick and wood, basement, two stories and attic, ornamental architecture.

242. Middle West, old; wooden, two stories and basement (?).

TRACK.

Item	Cost per Lin. Ft.	Add. For Each Switch.	Notes.
243	0.70	170.00	Based on use of "fit" (second hand) 67 lb. rail
244	1.00	180.00	Based on use of "fit" (second hand) 85 lb. rail
245	1.00 to 1.25	75.00 to 125.00	Based on use of new rail, according to weight.

TURNTABLES.

Item	Diameter	Cost	Notes.
246	70 ft.	$3,000	Exclusive of pit.
247	70 ft.	5,091	Including pit (?).

TRANSFER PITS AND TABLES.

	Cost per Sq. Ft. of Pit.			
Item	Pit	Table	Total	Notes.
248	.31	.17	.48	Far West, modern; to handle the heaviest class of engines.
249	.43	.16	.59	East, modern; pit of concrete throughout; capacity of table, 200 tons.

MISCELLANEOUS STRUCTURES.

Item	Name	Cost
250	Ash pit	$30.20 per lineal foot.
251	Coal chute	.65 per sq. foot.
252	Water tank	1,900.00 total.
253	Water pipe, underground laid	1.43 per lineal foot.
254	Sewer pipe, underground laid	2.88 per lineal foot.
255	Long lines of wrought iron pipe (for air, gas or water), with usual proportion of valves, fittings, etc., in place.	25.00 per 100 lin. ft. 1″ diam. 45.00 per 100 lin. ft. 2″ diam. 85.00 per 100 lin. ft. 3″ diam. 130.00 per 100 lin. ft. 4″ diam.

NOTES.

251. Two sided with trestle approach (?).
252. Fifty thousand gallon capacity on timber trestle (?).
253. Large system, pipes from 12 in. down to 4 inch.
254. Large system, pipes from 24 in. down to 12 inch.
255. Given by large pipe contracting firm of Pittsburg.

MINOR BUILDINGS.

Item	Name	Cost per Sq. Ft.	Cost per Cu. Ft.	Notes
256	Iron storehouse	.24	.011	Old, wooden (?).
257	Brass foundry	1.96	.098	Old, brick and wood (?).
258	Upholstery shop	.58	.029	Old, brick and wood (?).
259	Paint mixing shop	.58	.029	Old, brick and wood (?).
260	Paint storehouse	1.75	.087	Old, brick and wood (?).
261	Freight repair shed	.11	....	New, wooden, open sides (?)
262	Dry kiln	.79	.039	Old, wooden (?).
263	Lumber shed	.21	....	Old wooden open sides (?).
264	Storehouse shed	.31	.015	Old, wooden (?).
265	Coal shed	.24	.020	Old, wooden (?).
266	Coal shed	.25	.021	Old, wooden (?).
267	Charcoal shed	.21	.017	Old, wooden (?).
268	Ice house	.57	.028	Old, wooden (?).
269	Ice house	.60	.030	Old, wooden (?).
270	Crematory	2.52	.210	
271	Small office building	.50	....	Old, wooden, one story.

(The report ends here.)

CAR SHOPS.

The detailed percentages of two large buildings will serve as a guide for an approximate estimate.

	No. 1	No. 2
Excavation	.66	.23
Concrete foundations	7.40	5.38
Concrete coach pits	3.73	
Concrete floor in Coach Repair Shop	1.38	7.22
Concrete floors in two lavatories	.23	
Concrete water table and door sills	.38	1.29
Stone window sills	.28	
Brickwork	12.47	11.22
Lumber	5.56	3.68
Millwork and glass	2.68	2.84
Carpenter labor	2.67	2.73
Steel lintels	2.05	1.84
Structural steel (450 tons)	20.08	23.02
Unloading and setting S. steel	2.47	2.55
Galvanized iron and copper	1.58	1.73
Skylights	9.39	9.21
Gravel roof	1.58	1.93
Floor track	1.58	1.61
Hardware, ladders, lantern sash device	1.41	1.68
Lockers	.74	1.10
Painting	1.51	1.58
Plumbing	3.51	2.10
Heating	8.24	8.48
Air, steam and water pipe	8.24	8.52
Plaster in lavatories	.18	.06
	100.00	100.00

REMARKS: In No. 1 the total area over the walls was 85,980 sq ft. The cost as above, without architect's fee or contractor's percentage, $1.70 per sq ft. The hight to eaves 25′ 4″. No grading or filling is allowed. Owing to nature of ground the foundations had to run deep —one-half the amount might be sufficient for foundations and pits. If piling is required allow 7c per sq ft of total area. In some shops pits are not used.

The total area of No. 2 was 84,113 sq ft. The cost as on No. 1, $1.68. The hight to eaves 25′ 4″. No grading or filling. Foundations were as deep as on No. 1, but did not have to be so far spread as there was no piling.

In both the figures for heating and piping are approximate.

The following are the detailed percentages of a modern

BLACKSMITH SHOP AND A FOUNDRY.

	B'smith	Foundry
Excavation	.46	1.11
Piling	1.98	2.55
Concrete foundations and small floors	5.70	8.09

	B'smith	Foundry
Concrete water table	.60	.52
Cut stone window sills	.60	.51
Brickwork	13.70	14.81
Lumber	3.25	2.94
Millwork and glass	3.52	3.29
Carpenter labor	2.31	2.19
Gravel roof	1.39	1.43
Skylights	7.20	3.11
Steel lintels	2.58	3.58
Floor track	1.40	.22
Hardware, ladders, lantern gearing	1.31	1.47
Painting	2.67	1.40
Galvanized iron and copper	1.79	.80
Lockers	1.15	.84
Plumbing	4.10	2.66
Plaster	.24	.07
Heating, blast, exhaust, sump	3.34	7.73
Structural steel	12.55	28.28
Structural steel, erecting	1.54	3.41
Piping for air, steam, water, oil	5.27	4.20
Bins, outside and motor platforms	3.70	4.79
Machine foundations	7.01	
Wiring, lighting, power	6.00	
Furnaces and foundations	4.24	
Water filter	.40	
	100.00	100.00

Blacksmith shop, $2.14 per sq ft; foundry, $2.55. Add from 50 to 100 per cent to cost of buildings proper for tools and equipment. No grading or filling. No fee or percentage.

Outside foundry bins for coal, etc., 23c per sq ft on ground.

Carpenter labor on blacksmith shop, 5c per sq ft of area over building; car shop, 4½c; paint and wheel shop, 5.4c; foundry, 5.6c; mill, 6.6c; all at 40c per hour.

CRANES:	50 ton electric	$19,000
	25 ton electric	11,600
	10 ton electric	6,200
	15 hand	1,000

Motors included. Prices vary according to span, etc.

A comparison of sq and cu ft prices on actual cost of buildings proper runs as follows: Machine and erecting shop, $2.964 sq, 5.71c, cu; Boiler Shop, $2.665, 5.78c; Storehouse, $3.99, 12.2c; Pattern Shop, $2.863, 7.54c; Oil House, $2.03, 10.7c.

FOUNDATIONS FOR STEAM HAMMERS.

The following figures are approx, as depth, soil and manufactures' ideas differ. On good soil piles are unnecessary. See page 24 for cost of concrete for machine foundations.

800 lb. HAMMER:

1,050 ft lumber	$31.25
15 yds excavation	7.50
12 piles	72.00
12 cy concrete	84.00
Bolts	5.00
	$199.75

1100 lb.

1650 ft lumber	$49.50
15 yds excavation	7.50
12 piles	72.00
12 cy concrete	84.00
Bolts	8.00
	$221.00

2500 lb:

2,150 ft lumber	$64.50
25 yds excavation	12.50
16 piles	96.00
25 cy concrete	175.00
Bolts	12.00
	$360.00

5000 lb:

3,350 ft lumber	$100.50
30 yds excavation	15.00
22 piles	132.00
28 cy concrete	196.00
	$443.50

SAND HOUSES: On 2 the estimates were 78c and 80c per sq ft without crane. Size 14′x20′ and 16′x20′. Crane complete with base and labor, $156.00. On house proper labor is 50 per cent of material.
LUMBER SHED: Allow 48c per sq ft of actual ground surface, with deep concrete piers set 16′ centers. With piers about 4′ deep instead of 9′, 40c. About 16′ high, with second story floor over one-third of area.

REINFORCED CONCRETE ENGINE HOUSES: At Galewood, Ill., the estimated cost of 36 stalls was $80,000, or $2,200 per stall. This was for concrete up to the windows sills and brick above.

Another of the same design and 30 stalls was built at West Milwaukee for $65,000, or $2,167 per stall. Both were 84′ over all. (See also page 145.)

WAREHOUSE: The Railroad Gazette of October 14, 1904, gives the comparative cost of slow-burning wood, and a steel frame factory building with brick walls. The floors are designed for load of 100 lbs to sq ft. The size is 60′x100′, 7 stories high. Cost of slow burning construction, $35,000; fire-proof, $57,000. Per cu ft 6.2c and 10.2c; per sq ft of entire area 83c and $1.36. Cost of columns per sq ft 27c and 75c.

SLOW-BURNING.		FIRE-PROOF.	
Excavation	1,800 cy		1,800 cy
Cellar floor	6,000 sq ft		6,000 sq ft
Foundation concrete	150 cy		150 cy
Brick	39,000 c ft.		39,000 c ft
Windows, 4′x7′	238		238
Roofing	60 sqs		60 sqs
Timber, yp	116,000 ft bm	Steel columns	105 tons
Flooring, yp	73,000 ft bm	Steel beams	252 tons
Flooring, $\frac{7}{8}''$ yp	46,000 ft bm	Concrete floors	
Iron work	46 tons	and roof	42,000sq ft

The building is very plain. Basement walls, 24″; 17″ for next 4 stories; 13″ for 2 top stories.

For actual cost of mills and warehouses, especially in the south, see the 1905 edition of "Kidder," page 724.

ICE HOUSES: On 8 houses with floor space from 5,000 to 11,000 sq ft the estimated cost was from 80 to 96c per sq ft, with an average of 89c. Machinery, $600 to $900 each house extra.

On a house of later design, $1.10 per sq ft; 48c per sq ft of outside walls to level of wall plates, not including gables; 4.6c per cu ft to level of wall plates. Material, 60 per cent; labor, 40 per cent of total. Size 24′x160′x24′ high to plates. No machinery or percentage.

CISTERNS: For a 3,000 gall cistern, 8′x8′, 9″ walls, $100, 3½c per gall, or $1.66 per bbl.

For 100,000 gall 24′ diam, 30′ deep, 12″ concrete bottom, 9″ walls, $1,131, 1.131c per gall, or 57c per bbl of 50 galls.

CASES: An approx figures is given on page 17, and this may be supplemented by the following from actual work done:

A case 13′ 6″x18′ high, 33″ deep below counter shelf, and 16″ above was set in building, but not oiled for $165, or 68c per sq ft of frontage.

All the front was covered with sliding doors, one below counter shelf, two in hight above. On a $\frac{7}{8}''$ basis there were about 1,400 of lumber, including back. Below counter were shelves about 12″ apart; above were pigeon holes 6″x11″.

Another 9′ 8″x9′ 6″x3′ 2″ deep divided into 420 pigeon holes was set in place for $197, 47c per hole, or $2.15 per sq ft. The smallness of the holes and the extra depth account for high price, even although doors were not used. (See also page 91.)

SLIDING LADDERS for such high cases cost about $15 with track.

Mahogany wainscoting about 3′-6″ high, of average design, and good Tabasco material, $4 per lf, no oil finish. Allow at least 60c per sq yd for painter.

Marble base, $1.65 per ft.

Brass foot rail, $1.25.

SCRAP.

SPIKES: For heavy oak plank on bridges, etc., allow 1 keg of $\frac{3}{8}''$x8″ boat spikes per 1,000 ft bm.

TRACK: For 2′ gage track, old rail, 52 lbs, allow 30c per ft. For turntables, $50 each. Approximately 40c per track ft including turntables. For 8′ turntables, plain top, $200, Chicago; wt, 5,800 lbs.

CORRUGATED IRON: For No. 28 galvanized, $7 per sq in place. Not corrugated, $6. Labor from 75c to $1 per sq. Profit included.

For heavy galvanized iron, about 16 to 18, 12″ to 4′ diam, allow from 8 to 10c per lb in place, profit included. For 3″ mesh expanded metal, 6¼ lbs to sq yd.

CHAPTER XXIV

PRICE-BOOK

Prices sometimes change in a week, and estimates must change with them. An alphabetically indexed pocket price-book is useful, as each change of price can be entered under the proper date. A book of this kind soon becomes valuable and should last for years. I recently saw a good one 10 years old. Under N come nails, $2.25 or $2.60, as may be; C, cement, L, lime, etc.

Cement, Am. Portland, $2.40, 6-20-1901.
" " " 1.60, 3-21-1904.

CHAPTER XXV.

REINFORCED CONCRETE AND CEMENT STONE.

The shelves are beginning to groan with books on the subject. There is a wealth of theoretical discussion, and many excellent illustrations of work done, but scarcely anything about cost.

The following prices are taken from the work of Buel & Hill:

"A building of the factory type of reinforced concrete throughout, includings footings, outside and inside columns, walls, girders, beams and floor plates, roofs and stairs, will cost the contractor seldom less than $20 per cu yd of concrete in place, and of this cost from 25 to 35 per cent will be for forms, including materials, erection and removal."

But there is much difference in buildings.

"For example, the cost of the Ingalls building at Cincinnati" (See page 33) "including foundations, columns, walls, floors, stairs, etc., was $5.85 per cy of concrete in place, whereas in constructing a 4 story shoe factory in the same city, including only footings, beams, and floor plates, the forms cost the same contractor $6.25 per cy of concrete in place.

"For floor slabs of ex. metal construction, forms may be as low as $2.20 per cy on a 16′ span with a 400 lb load, and as high as $3.25 on a 16′ span with a 100 lb load."

"For beam and plate construction forms run from $5.50 on a 16′ span and 500 lb load, to $10.50 on the same span and 100 lb load."

"The forms for concrete steel floors will cost from 4½ to 6c per sq ft including everything.

"The forms for a concrete wall 4″ thick will cost from 8 to 11c per sq ft, measured on one side only.

"The forms for columns cost about 22c per lf.

"For floor work forms range from 10 to 20c per sq ft.

''Experience on about 30 buildings shows that it is rarely possible to furnish centering and remove it for much less than $4 per cy. The cost should never exceed $6.

CONDUITS: On a number of large conduits, forms ex. metal and concrete, but no excavation, cost was $10.50 per cy. In another part of the book conduit work is priced at $6.20.

On the $10.50 work the labor is given as follows: ''On the 6′ sewer the forms were made 8′ long; and two sections, or 16 l ft, were built in from 8 to 9 hours, including setting of forms, by one foreman, one carpenter and fifteen laborers. The total was 13 c yd of concrete.'' This 6′ sewer was not reinforced.

The same gang built 14 lf of 8′-6″ sewer in 10 hours.

The 9′ conduit contained 20 c yd of concrete, 1,200 sq ft ex. metal, 125 bags of cement for a section 13′-6″ long.

The forms were covered with No. 27 galvanized iron on the outside to leave a smooth surface on the finished work.

CLEANING: Cleaning bridges of concrete cost 60c per sq yd. On a plain part, not including moldings, balusters, etc., the cost was only 20 cents.

CEMENT STONE.

Under various names this artificial stone is becoming very popular. There are now, in 1905, 4,000 plants all over the country. Most of the stuff is hollow, some smooth, some ''tooled'', some rock faced.

In some parts of Nebraska this really fine building material is sold for as low a price as 14c per cf, and laid for 4 to 5c extra. Stone often costs ten times as much.

In Kansas City the material is laid in the wall complete at 32c per cf.

As an average for various states an Indiana manufacturer quotes 12 to 20c per block, not laid. A block contains about one c ft.

An Omaha price for a block 8″ high, 24″ long, 8″ thick is 20c, and about 7c extra for setting.

A Wisconsin contractor gives me the following prices: ''I manufacture stone 9″x32″x10″ thick, or 2 sq ft, for 9c per sq ft of wall. I pay 2c each block for delivery. I retail blocks at 35c each, or 17½c per sq ft. I put up wall complete, blocks, mortar, labor, and finishing joints above grade for 25c per sq ft.''

CHAPTER XXVI.
HINTS ON HOUSE BUILDING.

This chapter and the following one were not written for architects or builders, but for their ''victims,'' and may be passed over, if desired, by those who are well enough acquainted with all the tricks of the trade. It is not the want of information that keeps us back—there are libraries with a million volumes, and still we lag.

A traveling library could be filled with works on house building; here only a few hints are given for plain people who build plain houses. The other kind can hire experts. There are figures enough elsewhere in this book; these two chapters are for the average man and his wife, and are written in a popular way.

BRICK OR STONE VERSUS WOOD.

I never saw a wood house before I reached the shores of the United States, and one of the strangest and most beautiful panoramas that has never faded out of my memory in a score of years, was Staten Island and the white houses stretching over the land. They were not only interesting and strange in themselves, but had an added charm because I knew that the "Yankees" lived in them.

The best architect is he who can put up fine buildings with the material at hand. In Greece he used marble, but in the Low Countries he was driven to brick; and the development of the frame house in the United States shows that the plentiful woods of the forests can be made attractive enough in design and treatment to take the place of any material used in the older countries.

Which is best,—marble, stone, brick, concrete or wood? They are all best, but it often seems that the wood house is by far the most attractive, especially when newly painted. The average European idea of a wood house is a shelter of logs with the bark on, a hole in the roof to let out the smoke, and a few pairs of wolves' eyes glaring in through the darkness. We know that they are of a very different character.

The danger in a frame house is from fire, but when a fire breaks out the difference between brick and wood is not so very great after all. There is really no good reason why houses should be built within two feet of each other, as is often done. A visitor from Mars might inquire if there was a scarcity of land, or wonder to see one-fourth of residence parts of a city lying vacant. A city law might be made compelling owners to leave 10 feet between the nearest cornices of adjacent buildings, unless divided by a wall of fire proof construction. For light, ventilation and consequent good health, as well as fire protection, a law of this kind should be in force. But in Baltimore we recently had a lesson from a fire that went through all kinds of buildings.

If the workmanship is good, if the timbers are of the right size, and the outside covering of the proper quality, a frame house can be built as near perfection, from all standpoints, as any dwelling inhabited by man.

A brick house absorbs moisture, but it can easily be protected by wood furring, or by the inside lining of 4″ hollow tile that is now becoming popular. The plaster is put on the rough tile, without furring strips, and the danger from fire running up behind the lath is obviated.

The choice of material is largely a matter of taste, location and purse, except in some rather dull looking cities which do not permit frame houses inside their limits. Of course it is reasonable that certain portions of a city should be protected from the danger of fire-traps, but frame houses are an ornament to any residence district.

EXCAVATION.

Digging a hole in the ground does not require much explanation,—almost anyone can do that part of a contract. Sometimes a house is set upon posts to save expense, and if a cellar is afterwards required, the digging has to be done at a much increased cost.

Cellars are often plastered with cement on the hard natural earth. In some soils this system is satisfactory; in others it is merely a waste of money, as the earth crumbles away and leaves the broken surface. A lining of brick is better even for a cheap cellar.

FOUNDATIONS.

On page 35 the thickness of the walls of a one story cottage is given at 2 feet. This is one extreme; the other is 9 inches. Just about between the two is safe. For a basement of more than 6 feet high the walls should be at least 13″, or 3 bricks in width. If of stone they are usually made 16″, as that is about as cheap as 12″. Concrete should not be less than 12″. A 9″ basement wall, even 7′ high, is safe enough if really good brick are used, and if they are carefully laid in cement below the ground line; but very often inferior brick are used, carelessly laid in lime mortar, and in the end there is trouble that far outruns the original saving. A poor foundation is a luxury that few can afford.

The walls below the ground should be carefully plastered on the outside with good PORTLAND cement not less than ⅜″ thick, in the proportion of 1 cement to 2, or even 3, of sand, if the 3 is not made 4. It is strange that this simple precaution against water going through the wall is often neglected. A trifling saving is made, but there is, at least in some locations, a spoiled wall to watch and repair. As a safeguard of health, cellars or basements should have cement floors, and walls should be plastered on the outside below grade. Portland cement should be used for the ½″ top covering in the cellar, but the concrete below may be made of natural cement, although the other is better all through. The floor should be made about 3″ or 4″ thick, although 2″ can be made to serve. No. 2 has only 2½″.

The outside face brick ought to be hard. There is no cure for a soft brick in an outside wall but removal, and this is apt to be expensive. It is better to be careful at the start.

While, of course, hard brick are to be preferred all through, there is not much risk in a soft brick in the center of the wall. Unless of a very inferior nature a practical bricklayer would just about as soon as not use a soft brick in his own house, when concealed, but with face work it is different. Inside as well at outside it should be of good material with joints struck neatly with the edge of the trowel, and not with the flat in a plasterer's fashion.

Porch piers should not be less than 12″x12″.

A first class foundation can be made of stone, brick, concrete, or the artificial stone now becoming so popular. The chief danger is poor workmanship, and too much sand.

Many people prefer pressed brick for the outside walls. There are beautiful shades on the market, and it is a pleasure to look at a fine front, but first-class work can be made with good, common, hard brick. Europe has brick buildings hundreds of years old, of good plain material, and they are among the most beautiful specimens of the brickman's art. Some of the American architects are getting back to the

old style, the indispensable condition of successful work being brick made of good clay, well burnt and shapely.

Many fine pressed brick fronts are spoiled after a rainstorm by the alkali coming out; there is no danger of this with common brick, so that, all things considered, no one should be depressed by the fact that purse or locality forbid the more stylish article.

SIDEWALKS: It is best to put down permanent walks at first, and save trouble afterwards. Wood begins to rot as soon as laid. If it is used the stringers should be of white pine. Yellow pine rots in a very short time.

Cement or brick pays in the long run. (See pages 11, 16, 33, 53.)

CHIMNEYS: Hard brick should be used for all exposed work, and more especially above the roof. To repair a chimney above the roof is rather expensive, as a scaffold is required. Why not make it of first-class labor and material and be done with it for 20 years? A stone or iron cap should be put on, as the brick loosen at the top if left unprotected; or a heavy coat of good Portland cement may be used. It is better to lay all the chimney brick above the roof in cement—at the very least the top 12″ should be so laid.

A startlingly large proportion of fires are due to defective flues. In most cities now, tile linings inside of the brick are obligatory. If they are not used the joints should be struck on the inside and all the surface afterwards plastered. In time the plaster burns out, and the fire gets through to the woodwork. Carpenters should not be allowed to drive plugs of wood into chimneys.

A chimney should be as straight as possible, and be carried up above the highest point of the roof to draw well.

ROOMS: Make them as large as you can, but not too large either. Why heat useless space? "A little house well filled, a little farm well tilled." In most houses only one room is really well heated in winter. The one selected should be made the largest.

Make the second story rooms full hight. There is not much economy in half story rooms with a part of the slope of the roof used, and they are hot in summer.

I have followed this method of construction several times and regretted it. Rather than do it again I would leave off all the lath, plaster and finish on the full hight top story, and wait till money enough was at hand to finish a house that would always please and not sometimes provoke. Of course, some have to be content with this construction, but it is not desirable.

DORMER WINDOWS: The half story house often make them necessary. If there is any place that requires care it is a dormer window. If they once begin to leak there often seems to be no cure but tearing down to find the trouble. The best tin, the best workmanship, the best paint are necessary.

CLOSETS: In spite of the newspaper jokes, neither architect nor contractor delights in small closets. There are, of course, some who waste money enough on useless ornamentation to give plenty of closet space, but in general small closets are due to small pocket books. Many,

in fact most, women do not have any idea of sizes when marked on a plan, and are disappointed when the house is built. It often seems that a good idea would be to have a covered enclosure in a city where for a small fee 2″x4″ plates would be laid down and moved to suit the actual sizes wanted. It is easy enough to make rooms and closets of any required size if the cost is not limited, but it is hard to supply a No. 1 article at a No. 4 price.

CEILINGS: Some are made 11′ high, others 9′. For the first floor 9′ 6″ is the lowest hight that ought to be used, and 10′ 0″ makes a better house. For the second floor 9′ 0″ is low enough, but 8′ 6″ is sometimes used. These hights are between finished floor and plaster. Allow for sheeting, if put on, top floor, and plaster, or 3″ altogether.

WOOD FRAMING.

SILLS: Some prefer a solid sill laid on the basement walls, and others use a "box" sill of two planks, the one flat, and the other of the same width as the joists standing on edge on top of it, and flush with the studs, which are set on a plate of their own width nailed to the planks. I like the box sill, as the full strength of the joist is insured, but some cities make the solid sill obligatory.

When a solid sill is used a notch has to be made for the joists which are then cut to fit. Usually they are cut about half way up, and the whole bearing comes on the upper half, while the lower is left to swing free instead of being blocked up on the foundation. We know that a good carpenter does not do such work—we also know that in half the houses built the joists have their throats cut in just this fashion.

GIRDERS: Many cottages are spoiled for want of a central girder with posts set on wide foundations to support the joists. When the weight of the plaster is put on the floors begin to sag.

JOISTS: The joists should be 2x10's well bridged; 2x8's are strong enough if the span is not too great. Even for an attic floor not less than 2x8's should be used. The saving in using 2x6's is not very much, and if the span is wide the floor is spoiled and the plaster below cracks. On a cottage 22′x40′ the difference in cost in 2 inches of width is only about $6, for joists set 16″ centers. Why spoil a house for $6? All floor joists should be bridged when the span is more than 8′. Below partitions joists should be doubled, or 2x4's spiked in between the two bearing joists.

WALLS: The walls of the average house are usually built of 2x4's set 16″ centers; 2x6's are better, unless for small cottages, as, after surfacing, the 2x4's are only 1⅝″x3⅝″. Rough lumber costs about $1 per 1000 more, owing to freight. All window and door openings should have double studs. All corners and doors should have nailing blocks for base, as there is no nailing on the stud after the thickness of the plaster is deducted, in the corner, and after the door casing is put on. There is a good deal of difference between a well built house and one of the other kind.

RAFTERS: In some cheap houses the rafters are set at 2′ centers —they should not be set more than 20″ in any house; and 16″ or even

12″ is often used for long spans, slate or tile roofs, etc. For cottages 2x4's are large enough, but 2x6's should be used for a really good house. Too many carpenters neglect to brace and tie ceiling joists and rafters together, and the roof sags. Many roofs are spoiled before the carpenter has time to finish his contract, for want of a little care and a slight expense.

The least pitch of a shingle roof should be $\frac{1}{3}$. A pitch of $\frac{1}{2}$ is better, especially if attic is to be used. (See page 83.) For a gravel roof 1″ rise to 12″ is enough.

BOARDS: Roof covering is best laid close in cold climates, but it is sometimes kept about 2″ apart to save lumber.

SHINGLES: The best on the market should be used. There are many places to economize, but the roof covering is not one. I have a cottage with cypress shingles put on about seventeen years ago. They have never been repaired, and are still in fair condition. Exactly four years ago, when short of cash, or suffering from a streak of economy, I shingled another cottage with a second grade quality of white pine shingles. They are already loose, the nails are rusted, the nail holes worn, and in about a couple of years a new roof covering will be required. That is a practical illustration of quality. As the labor on a poor shingle is often more than on the best, the advantage of putting on the best is easily seen. Galvanized nails should be used, as they do not rust like the common kind. Shingles should not be laid more than 4½″ to the weather, unless on a very steep roof. Even on that 5″ is the limit.

There are some excellent stains on the market, and it pays to dip the shingles For the cost see pages 15, 113, 114. If stain is not at hand, linseed oil may be used, as it is a good preservative. Common paint is not desirable, as it glazes over the surface and ends, catches water, and induces dry rot, while the oil or stains go into the pores, Some roof paints are rather suspicious. Good linseed oil, the base. costs 60 to 70c per gallon—how can paint be sold for 40 to 50c if the requisite proportion of oil is used?

BOARDING: Either common boards, shiplap, or flooring will do for the outside covering. Usually the boards are nailed on horizontally, but sometimes on an angle of 45 degrees. Waste and labor are greater, but the framework is better braced with angle boarding. Sometimes, again, men without a conscience nail the siding directly on the studs; in buying a house built in a boom town it is advisable to see that there is sheathing between the siding and the framework. Paper must be used between boards and siding.

BASE AND CORNER BOARDS: Good houses have a board around them at level of foundation. The sheeting should be flush with the masonry, and the base board set down about an inch to cover the joint. The water table is nailed on top to receive the siding. Corner boards and frame casings should be 1⅛″thick. Sometimes the base board is not used, but the siding is put clear down. As a picture looks best inside of a frame, so does a house inside of a border.

SIDING: White pine siding is the best, but it is not so common now as formerly. A good substitute is California redwood or cypress. Siding looks well when mitered at the corners, but costs more than if corner boards are used. But unless the lumber is dry the corner board shrinks, and a bad joint is the result, clear from base to roof.

Either 6″ or 4″ siding is standard, but the narrow kind is now used on the best houses. It costs more than the wide. (See page 14.)

Sometimes the sides of a house are shingled. I do not like the style, but it is a matter of choice. Gables, bay windows, bands, etc, look well when treated in this way, but an entire house covered with shingles is rather monotonous.

PORCHES: Do not make the posts too large for a cottage. In former years they used to be about 4″x4″,—now they are 12″ in diameter. A four-room cottage is not a Greek temple. Why put up such disproportionate columns for a little porch? Is there no fair medium between the spindle and the ''monolith''? The modern style sets people of a sarcastic nature talking about ''beer purses and champagne appetites'', "the tail wagging the dog", ''Queen Anne fronts, and Mary Ann backs'', and so on.

The ordinary porch of a dozen years ago was spoiled by being made too narrow. The minimum width from house to outside edge of floor should be six feet. Six inches of that, at least, are lost by posts and railing. The wide veranda is becoming popular.

TOWERS: There is a difference between a cottage and a castle. Each may be a beauty, but what fits one may be out of place on the other. Be sparing of towers, drawbridges, moats and battlements on an ordinary house. After all, plain Mose Smith is a far better neighbor than Sir Brian de Bois Guilbert would be.

THE LINE OF BEAUTY: For outside work in general, an architect of experience will not use much fancy scroll cut material, brackets, ridges, circles, curves, etc. The amateur and the country carpenter delight in that kind of display, but the owner of the house has to pay the bill in a very few years when the sun and rain do their work. Just as with marble, stone, brick or wood houses the architects of all countries in the years behind us have had to adapt themselves to the materials at hand, so their brothers of America might just as well accept the July sun as an established fact and stop fighting it. The contest is too unequal.

There is a difference between the simple, beautiful, square house with the plain roof, and the one we built when Queen Anne was the reigning monarch. The bills for repairs have been coming in since then.

WINDOWS: In many ways the little details of American houses are more convenient than those of European ones—but rattling sash are unknown in Europe, while they are everywhere here, and they are anything but a blessing. The trouble is with the outer sash. It is made to fit easy, and it fits loose. As the blind stop and the parting strip between which it slides can not be moved the rattling comes as soon as the wind rises. If the meeting rail were left wide enough to plane, and fitted hard against the one on the inner sash, the pressure

would prevent rattling there especially after the lock was in place; but machine made stuff must be ready to slide without planing and there is no margin left for a proper fit.

The inner sash can easily be fixed right, as the stop can be moved in to suit. Stops should be screwed on, but they are usually nailed in ordinary houses.

FLY SCREENS: They are most serviceable when they cover the entire window on the outside, as both sash can then be moved, but they cost more than half screens and rot sooner owing to exposure to the weather Outside blinds cannot be used with full screens.

BLINDS: Neither outside nor inside blinds are so popular as they once were, especially for good houses. Heavier glass, sometimes plate, is used, and the danger of breakage from hail is ended. But, of course, the New York ruralists will cling to them for ages yet. As salt goes with egg, corned beef with cabbage, and butter with bread, so with them, green blinds go with white houses, one and inseparable, now and for evermore They are truly rural.

GROUNDS: To keep the plaster straight it is better to use grounds all over the house. There are from ⅝″ to ⅞″ thick x 2″ wide, planed smooth on one side, and are nailed around all openings, and under base, wainscoting, etc. In cheaper houses the window frames and finished door frames are used, so that the expense of grounds may be saved. (See pages 76, 85.) But the plaster stains the wood, and if natural finish is used instead of paint the blemish is always seen. If grounds are not put around window openings care should be taken to keep lath clear of the frame which is often pushed in far past the straight line.

Grounds may be left off under base if the plasterer is careful with his work. But if they are not used the position of the studs should be marked on the floor before the plastering is done, so that the base may be nailed solidly, and not merely to the lath.

FINISH.

FLOORS; Yellow pine flooring is not well adapted for outside work, at least north of Mason and Dixon's line. When laid near the ground it rots in a few years. White pine is the best; Oregon fir is a fair substitute.

If the expense is not too much, under floors of sheeting, shiplap, or cheap flooring should be put down all over the house. The plastering is then done before the finish floor is laid. On the first floor, as least, an under floor should be put down, and after the plastering it finished, building paper and the finish floor. It is better laid on an angle of 45 degrees, not merely for bracing, but because of a more equal surface than when the boards run parallel with the top floor. The inequalities of the under floor are not then reproduced on the upper one.

The new and better style is to use rugs instead of carpets, and good floors, or at least, good borders are necessary for them. Good oak floors cost money. (See pages 13, 75.) But if ⅞″ material is used a

hardwood border only may be put down, and the center of the room filled in with ordinary flooring. There is no real necessity of covering the whole floor with hardwood. The thin material may be treated in the same way, but special flooring is required for the center, while any lumber yard carries $\frac{7}{8}''$ material.

When laid after plastering, and well smoothed and varnished, good yellow pine makes a beautiful floor, as fine a floor, indeed, as the average man could desire. 'Tis the average woman who sighs for the other.

Quarter sawed, or "rift" sawed, yellow pine is by far the best material. There are several grades of this. The common flat sawed flooring becomes in time a source of trouble with slivers. There are also several grades of this common stock. The difference between edge grain, or q s, and the common No. 1 in a house 22'x40' is about $11 per story. If the quarter sawed is not used for the main part it should certainly be used for the kitchen, as there is no possibility of slivers arising from the edge grain, owing to the way the tree is sawed at the mill. The old flat grain is never used in a good house now.

Flooring should not be wider than 4", or $3\frac{1}{4}''$ face. Narrower than that is better, but more expensive. Care should be taken to prevent the use of too many short lengths. (See page 142.)

Narrow maple really makes the best kitchen floor, but it costs money to put it down. (See page 13.) Square edged is not adapted for houses.

Oak floors are used in the front rooms. They are even more expensive than maple, and require to be carefully laid. They ought to be quarter sawed to look well. The $\frac{7}{8}''$ are best, but the thin floor is often used. (See pages 13, 75.) White and red oak are used. White is harder and better than red—and costs more.

It is a mistake to lay floors too soon, unless in summer when the plaster soon dries. Neither architect nor contractor is to blame for dampness in a new house, as natural conditions cannot be forced: but kiln-dried flooring, doors, etc, immediately begin to swell when put in the building. The doors have to be stripped until they will close, and when they dry they are too narrow to look well. The floors shrink until they are spoiled. We are a very illustrious people here, as it were, but we have acquired the unfortunate habit of planting a bush at night and going out to pluck a rose next morning.

JOINTS: Ill-trained carpenters often make the joints of a floor all clustered together, owing to the length of the boards, when they might as well be distributed; and they join members of base, cornice, etc., within too short a distance, thus spoiling the look of the finished work and weakening its strength.

STAIRS: Make square platforms, unless winders cannot be avoided. See that steps and risers are grooved together and blocks glued in behind, or the stair will soon creak. Try to so arrange a plan, for even a cheap house, that there is a separate entrance to the kitchen from the stairway. This is often done by making one stair serve from the second floor to the first landing, but running two flights from there down to first floor, one to the back, another to the front part of the

house. There should be a passage at side of stair from the kitchen to the front door, so that the main rooms need not be used.

DOORS: Narrow doors are a source of much trouble. Front, kitchen and cellar doors should not be less than 3′ 0″ wide; main room, 2′ 10″; bed room, 2′ 8″; closet, 2′ 4″. A closet door may be 6′ 0″ high when below a stair, etc, but 6′ 8″ is the least desirable hight for any door, and 7′ 0″ is better. Doors ought to be on a level if possible. Transoms give light and ventilation to halls. Some do not like them

CASINGS AND BASE: Finish of all kinds is easiest treated when plain. The Japanese, among their other eminent qualifications, have the knack of living in simple houses with simple furniture. We fill houses full of hard work, and scrub and fight and worry over useless moldings, useless furniture, useless stair ornamentation, grilles like Chinese puzzles, and a score of other useless dust collectors. It is done to please "flub-dub" architects who talk of "Louis Quinze, Seize, Quatorze," or some other man or woman with a thousand servants.

Why were we so slow in discovering open plumbing? It seems strange that we should have used the old kind so long. Our descendants will say, "Why were they so long in discovering simplicity of style in houses and furniture? Why did they keep their shoulders below useless loads?" Here, we are at least further advanced in the right direction than the British and Germans. They box everything, and make their furniture heavy enough to last for a thousand years.

The under side of the casings of a window should be within 6″ of the ceiling, if we are to believe the sanatarians. This gives good ventilation, but spoils the border for paper and picture mold. Each builder must decide for herself whether esthetics or health is to have first place.

WAINSCOTING: The walls of kitchens and bathrooms are seldom wainscoted now. They are either plastered with hard plaster or tiled. This style of finish is much better. Of course, paneled wainscoting is still used in fine houses.

Dining rooms look well with paneled wainscoting. It gives a kind of a "baronial" flavor to the ordinary house, but it costs a good deal. (See page 90.) A plate molding may be used if wainscoting is too expensive.

WOODS: There are a score of woods to choose from. White pine,—or yellow pine as we used to call it on the other side, our yellow pine being known as "pitch" pine,—is better for paint and better than yp even for oil finish. The best grades are now so expensive, however, that some millmen would just as soon supply red oak, which, of course, requires more labor to put in place. The usual fashion for a house costing from $1,800 up, is to finish the main rooms on the first floor in oak, or some other hardwood, and make yp, cypress or a cheap wood serve for the kitchen and upstairs. White oak is more expensive than red; quarter sawed than plain, but the difference is seen in the finished work.

GLASS: Beveled plate looks well, but again we come to the old trouble,—it costs more than common plate. Plate glass is far superior to common glass, AA. common to A., and A. to B. Double thick is natur-

ally stronger than single. (See page 93.) When good plate is put in it can scarcely be seen, if well cleaned. There are two qualities of plate.

In general, it is a mistake to use circular or bent glass. If a light gets broken it is often necessary to wait for weeks before another comes from the factory, and the price is several times as much as for straight.

The best work is bedded with putty before the glass is laid in the rabbet, then small galvanized angular brads, or points, are pressed in to hold the light in place. Common work, mill glazed, is often left without back putty.

TIN: Some prefer gutters built up on the roof rather than those which hang at the eave. The roof gutter looks a little better, but costs more. Other gutters are concealed inside of the cornice, clear of the walls, just as the hanging ones are, so that there is no danger of water going through the boarding if a leak takes place. The roof gutter should also be clear of the main wall.

It is cheapest in the end to use the best tin, but even if the poorest material is used, with a hanging gutter there is no trouble in putting on a new one. It is otherwise with those that are built up. The tin goes under the shingles, and several courses have sometimes to be taken up where repairs become necessary, and the expense is considerable. The best material should be used when running under shingles, and it should be painted two coats of mineral paint on the under side before being laid, to prevent rust, and two coats on the upper also when in place.

In valleys, especially, where two roofs meet, the one plane running north and the other east, for example, see that the best quality of tin is put down regardless of the cost. Economize on something else than tin in such a place, for if poor material is used and the shingles—all cut to an angle at the bottom— have to be lifted on both sides to get the new tin under, repairs are unusually expensive. The old proverb of penny wise, pound foolish applies here.

The difference, then, is clearly seen: one may use poor tin for hanging gutters, or they may be left off altogether, for that matter, but flashing around chimneys, dormers, valleys, tin shingles on corners and such work as can not be easily repaired without tearing up the roof should be of the best material carefully painted.

Some of the best brands of tin are Taylor's Old Style, M. F., and Merchants Old Method. These brands are stamped in the sheet. I. X. of the various brands should be used for valley linings.

Galvanized iron is now often substituted for tin, and it is better than the cheap brands, but not so good as the ones mentioned above. (For prices see page 99.)

Pressed brick siding, rock faced siding, tin shingles over entire roof, and such devices to imitate better material, are seldom seen in cities, but are much admired by those whom the New York Sun—"The Impartial Shiner"—calls "the ruralists."

LATH AND PLASTER.

LATH: Metal lath is the best, but it is more expensive than white pine, the next best. It is seldom used for ordinary dwellings, but both for clinching the mortar and for fire protection it is superior to wood. But for metal the joists or strips, especially on ceilings, should not be more than 12″ centers, as it sags at a wider distance. When joists are wider they are usually furred with 1x2's.

For wood the joints are broken every 15 inches or so to keep the plaster from cracking in a straight line from floor to ceiling. Outside brick walls are now often lined with 4″ hollow brick which take the place of the inside course and make the use of wood strips unnecessary.

In Scotland split lath is used almost exclusively, and it is much better than the sawn lath, as the surface is necessarily straight grained and not cut across, thus weakening the strength of the wood.

Lathers should not crowd lath against window frames.

MORTAR: Cement plasters have now taken the place of the old lime kind. (See page 67.)

Sand for all plasters should be screened. It is possible to spoil the plaster by using too much sand.

The ordinary small house is finished in two coats, but all, except the very cheapest, should have three. The first coat, the brown coat, usually put on at the same time as the first, and, after thorough drying, the white, or putty coat. Sand finish is not usually put on dwellings, but it is best for halls and large rooms where the surface is to be painted instead of papered. Three coats are necessary for metal lath, as the first has to be thin and dry before the next is put on.

The walls of kitchens, pantries, corridors, halls, stairs and bathrooms are now often finished to a hight of 3 or 4 feet with the hardest of cement plasters, such as Keene's Best Cement, and no wood wainscoting used. It is the cleanest and best finish short of enameled tile or such expensive material. At base, wood wainscoting, and around all openings where wood finish is to be nailed on, the plaster should be carefully straightened.

It is sometimes hard to keep even the best plaster from cracking. Muslin screens should be put over all openings to keep out the hot summer air which dries the mortar too soon.

After a time, where paper is not used, burlap is put on the side walls and unbleached muslin on the ceiling and the surface painted, but ordinary houses are not usually treated in this way. The burlap is either plain and painted after it is put on, which appears to be the more satisfactory way, or it can be bought already stained in various shades. The joints should of course be butted and not lapped like some cheap wall paper, as it is thick. It is too heavy for ceilings.

HARDWARE.

See page 117, and buy according to your purse. Good, serviceable, and even beautiful, hardware may be had at a very reasonable price. All the rest is leather and prunella, bowing in the house of Rimmon, and so forth—but the hardware men are as much entitled to their

share of the extravagance as other merchants, and they can supply a quality of goods which would have surprised the founders of this republic. We excel in hardware on this side of the Atlantic.

Use loose pin butts, so that doors can be removed without using a screwdriver. Cast iron is cheap, and may serve for years, but may be broken in a day; wrought iron is safer. Put on mortise locks, not rim locks. Sliding doors should be hung from the top. Some run on the floor, others on side devices. Sash should be hung on weights, and not on any kind of balances. (See page 77.) If fly screens are to be put on the inside, which is the ordinary way, flush sash lifts should be used, as the hook or bar lifts project from the sash.

Under no circumstances should hardware be put on before the painter is finished. It is next to impossible to paint around it without smearing. With varnish the results are worse than with paint, for the one is seen, and the painter has to be careful, but the other is not, and is run over the face of locks on doors and windows, clogging them and preventing working. The hardware man is often blamed when the painter is at fault.

PAINTING.

Shingles should be dipped, but not painted.

Houses are often painted with only two coats on the outside, but at least three are necessary to give a proper finish. White lead mixed with linseed oil is the best material for the first, and subsequent coats, with the coloring matter added. We live in an era of adulteration, when even food is poisoned, and baking powder partly made of ground rock, and why expect pure white lead? Ochre is not so good as lead, but it is cheaper, and is often used for the first coat.

The former style of decorated painting is now out of date. Houses are often painted in only one color, with the exception of the sash. Pure white looks well, but it can not be produced with fewer than three coats, and four or even more, are better. A shade of coloring matter hides many deficiences at first, and much dust afterwards.

A good painter will never do any puttying before the first coat is put on. The raw wood absorbs the oil from the putty, and it dries and falls out. For the same reason the rabbets of sash must be primed before the glass is put in.

There is more opportunity for using poor material in painting than almost any other branch of building. Architects usually specify that all materials must be brought to the job in original packages. Good paint lasts for a long while; poor paint fades in less than a year.

INSIDE PAINTING: There is the choice between paint and finishing in the natural color, or staining and varnishing. (See page 114 for standard finish.)

White and gold make a fine combination, a beautiful finish, but from five to eight coats are required to cover the raw wood and bring out the proper shade. Such work is expensive. It is not possible to get the white effect with two coats. A little color, inside even more than outside, covers all blemishes, and makes a cheaper finish than

the pure article. Yellow pine is not adapted for painting nearly so well as white pine, or cypress.

A cheaper finish than the pure white may be had with the usual hard oil treatment. Of course, this does not mean the first quality of work with the requisite number of coats, and rubbing down, but merely a presentable finish at a cheaper rate than for pure white paint. But with a little ground pumice stone and linseed oil any one can do the rubbing down to the much admired "egg shell gloss," and save that part of the painter's bill, or, indeed, buy the material and put on all the coats. (See pages 114, 115.)

FLOORS: There are a hundred and one preparations for hardwood floors. Painters stand by the regular finish, and it is sure: Paste filler, two coats of grain alcohol—not wood alcohol—shellac, one coat of good varnish, sandpapered between coats and slightly rubbed down on the last. For all work sandpapering is essential, and it should be done with the grain of the wood, and not across.

Another good finish is filler, and waxing two coats with a weighted brush. Still another is filler, one coat of shellac, and one of wax. Or filling and two coats of floor varnish, or florene, but this is not so good as the shellac treatment. Floor varnish costs about $1.75 per gall., shellac, $3.50.

An experienced painter gave me his choice for floors as follows: No. 1. Filler, one coat of shellac, two of varnish, and rubbing down. Cost, with profit included, 50c per sq yd. No. 2. Filler, one coat shellac, one of wax, 30c. Such woods as oak require to be filled owing to the pores; yp, wp, etc, do not require filling.

If plaster is painted in ordinary fashion, it should be stippled to take off the brush marks and the gloss. But bath rooms, etc, are often finished in enamel paint. A coat of glue size is used on plaster before painting.

HEATING.

Stove heat is good, furnace heat is better, and hot water heat is best. In our foolish days they used to drill us on Positive, Comparative, and Superlative, and here they face us once more. The first cost of the hot water plant is often 40 to 50 per cent more than the furnace one. This makes it superlative in two senses.

CHAPTER XXVII.

COTTAGES IN SPAIN, OR THE BUILDING OF THE NEST.

Being an Idyllic and Popular Chapter.

We have all heard of castles in Spain, but our age runs to cottages built in the same delightful country. For a thousand dollars you may have one while you wait, if the illustrated magazines are to be believed, with seven rooms, modern plumbing, electric lights flashing from cellar to roof, and doors and windows made to let in filtered sunshine and keep out flies and burglars. It is magnificent, but jealous contractors say that it can't be done. The magazines, they say, are serving up the strongest quality of fiction in their advertising pages. It does

seem strange that people can be gulled so easily as to swallow the fables. It seems stranger still that reputable magazines will print the absurd advertisements.

It may be accepted as a fact that good building costs a good strong price; it may also be accepted as a fact that contractors seldom make more than a close living if they spend their lives building small cottages in competition. They are cut to the bone. I have not built any for a dozen years, and so can give a fair chapter without bias.

On page 148 an approximate figure is given for frame houses—$300 to $350 per room without modern improvements; $450 to $500 with the best finish. I built my last one in St. Louis. It cost, without modern improvements, $330 per room; I know of an Omaha house now being built, 1905, one like scores of the very best kind with everything modern, and the cost per room complete is far nearer $600 than $500. These are for cities at city prices; in the country, prices can be cut, but not quite fifty per cent.

The St. Louis cottage was 28 ft wide by 32 ft long, with no angles. It was made as plain as possible, and yet looked well. The ceilings were 9′ 6″ and 9′. 0″. A cellar with earth floor extended throughout the entire area. Walls were of stone which was supplied free of charge. There were three rooms and hall on each floor. Attic had sheeting floor, but was unfinished. A plain front porch ran across one end, and there was a small balcony an second floor. Practically one partition ran each way dividing house into four spaces. There was a sliding door. The finish was all pine and painted. The people who are learning from the magazines how to make resplendent bookcases out of old soap-boxes could build such a house for a few hundred dollars, but a contractor cannot. It was well built. The walls were covered with sheeting, paper and siding; the floors were of yellow pine. Sometimes the sheeting is left off.

The parlor was 14′ 3″x15′ 4″, sitting room, 14′ 3″ x14′ 6″; kitchen, 12′ 3″x14′ 3″; hall, 12′ 3″x10′-3″; Bedrooms, 14′ 6″x14′ 3″; 14′ 0″x14′ 3″; 12′ 3″x14′ 3″. There were two closets on second floor, and a pantry on first. There were two chimneys.

	Cost	Per cent
Excavation	$30	1.6
Basement, chimneys and pipe drain	240	12.6
Lumber	482	25.3
Millwork and glass	227	11.9
Carpenter labor at 40c per hour	475	24.9
Plaster	148	7.8
Hardware	60	3.1
Tin and kitchen sink	60	3.1
Electric wiring	27	1.4
Mantel and hearth	36	1.9
Paint	122	6.4
	1,907	100.0

That is actual cost; at $330 per room a small margin is left for contractor's profit. Nothing is allowed for outhouses, sidewalks, clothes-poles, fly screens, cistern and broken glass. A cistern lined with brick is worth about $50. Over walls, deducting recess, there are 860 sq ft at $2.22.

Labor and material are higher since then. Such a house is worth $2000 in Omaha, St. Louis, Chicago or a dozen of other cities which might be mentioned. If lumber can be bought for $9 instead of $18 that is another story; but no one should believe that magazine prices will pass in the average city.

(See page 18 for percentage of frame buildings.)

Carpenter labor is one of the largest items, and runs to about 1,200 hours; the first contract I had was for a five-room house and with making much of the millwork by hand the hours were close to 1,000. Another house of the same style, about 900. For a fine seven-room, hardwood finished house, including oak floors, the time was 2,200 hours. Mitred siding, fine cornices, fancy roofs, and magazine half-tones in general take a great many hours. (See page 75 for floors.) On the cheapest house I ever had the carpenter hours ran to 460 for three rooms, a pantry, a very plain front porch, and a chimney set in mid-air, a building so plain as to be totally unfit for the pages of a magazine. The cost was about $500.

In some parts of this wide continent foundations need not go more than a foot in the ground; in other parts they ought to go four feet to clear the frost line. Double floors are used in the best houses; single are sufficient in warm climates. The best shingles are expensive; the kind sometimes used are scarcely fit for a stable. The workmanship is often of very poor quality; where studs should be double they are left single. (See "Studs" page 82.) And so on in a score of ways. But even with the cheapest material and labor, and the poorest workmanship it is impossible to keep abreast of the magazine heroes.

In Vermont, I once worked as a carpenter for $1.50 per day; in Oregon lumber sells for $8 per M; in the southern states foundation walls do not require to go very deep; and in Iowa there is a settlement where the houses are left unpainted—but the difficulty is to get all these various advantages "assembled;" and they are all required before the magazine cottages can be built at the given price.

The other night a contractor and I looked over a model plan that might please any small family. It has appeared in several magazines, and is deservedly popular. The perspective of the house is in keeping with the well designed floor plans.

There are 3 rooms on each floor, and a large hall on the first floor. There is a bath room in the second floor hall. On the first floor there is a large pantry and coat closet; on the second, an alcove and two closets. The house stands high enough to show the cellar lights clear of the ground; and is crowned and ornamented with the popular Dutch roof. The St. Louis house was square and without projections; this one has corners and bays spread all around, each one adding to the cost; and instead of one plain cornice there are two heavy ones. In pro-

portion to size it is in every way a more expensive house to build. The area is about 675 sq ft as against 860, but the cost of houses of nearly the same size is not in all ways reduced in proportion to area, for there are practically the same number of openings to consider for millwork, and stairs are the same.

We made a rough estimate of the cost and agreed on, at the very least, $2,000 for Omaha, and other cities; and we made a cut rate for a cheap locality as follows:

	Cost	Per cent
Excavation	$25	1.5
Masonry	220	13.0
Lumber	320	19.0
Millwork and glass	230	13.5
Carpenter labor	350	20.6
Plaster, 600 yds. at 22c.	132	7.7
Hardware	50	3.0
Tin	40	2.3
Mantel and hearth	30	1.7
Paint	100	5.9
Plumbing	200	11.8
	$1,697	100.0

Contractors are popularly supposed to make large profits. The usual allowance may be added for them. Electric wiring is not included, as the specifications were not at hand, but that and other extras may perhaps be specified also.

As we looked at our figures and the published price there was a considerable difference. According to the magazine advertisement the house has been built several hundred times for $1,125, presumably including a good profit for the contractor. No wonder the plans are selling. That is only $188 per room with plumbing thrown in.

But for a "cheesebox" cottage the low figures will pass; and a plain house that is owned by the occupants is more to be desired than a stylish one owned by some one else.

Take a rectangular house 18′x36′, with no projections, 4′x9″ foundation, 9′ ceiling, three rooms and pantry, plain proch, chimney set on a bracket, and the cost at city prices, should not run over $648, or $1 per sq ft. If posts and sheeting are substituted for brick foundations, $600 is enough. Painting, set at $50, might be done later on, and $550 taken as the figure. But this means a hole dug in the ground for a cellar, pine finished, no fancy angles outside or inside, no blinds, no sink, water supply, or cistern. In some localities half that figure would be enough. Omaha, Chicago, St. Louis, Salt Lake City, New York, represent the one extreme; the mountains of North Carolina, the forests of Washington and the pleasant climate of Florida make the other possible.

The porch left off cuts the price down $50 more; and for those who prefer a home of their own without plaster to a plastered one belonging to some one else, for the course of the summer, a deduction of $75

may be made. But a contractor could not build such cottages and live. A good carpenter, just starting out, is willing to take such small contracts for the chance of making a little more than by working by the day.

But let the distinction be kept clear between such ordinary shelters and the miniature palaces shown in the magazines.

In looking through some recent trade journals I found a house almost the same as the St. Louis one, and the trade publications have to present another kind of estimates than those in the illustrated magazines, for their readers are acquainted with prices.

The size is 28′x30′ over all; there is a cellar throughout entire house. There is no hall, but four rooms and a pantry on first floor, and four rooms with closets above. The division of the partitions is practically the same, but a box stair is used. There are only four corners, and the finish, outside and inside, is of the plainest. The ceilings are 9′ 0″ and 8′ 6″. It is as plain a house as could be built, and yet the cost per room is $278, and the rooms are small. The cost and percentages are as follows:

	Cost	Per cent
Excavation and masonry	$315	14.2
Lumber	538	24.2
Millwork and glass	390	17.5
Carpenter work	420	18.9
Hardware and tin	100	4.5
Kitchen sink	40	1.8
Plaster	180	8.1
Painting	140	6.3
Incidentals	100	4.5
	$2,223	100.0

On the St. Louis house some of the millwork was made by hand thus reducing cost of this item and raising carpenter work; on the foregoing house the millwork is figured ready to put on. The rate per hour of carpenters is not given. But the two houses make a very close comparison.

On the first the cost per sq ft is $2.22; on this one the cost is $2.65; on still another plan, originally made by a friend for competition in "The Ladies Home Journal," but never sent in, the cost is $4.14, the difference being due to furnace, plumbing, detail work and better finish.

"Did you send in the plan?" I asked him, "No," he replied, "when I found that the cost ran to more than $4 per sq ft without contractors' profit I let it go."

His plan is square, 29′x32′ with a cemented basement all through; attic is floored but not finished; there are halls and four rooms on each floor besides two bath rooms, and plenty of closets with windows. Counting bathrooms makes ten rooms at $384 each. The estimate made for him by a contractor is given below:

	Cost	Per cent
Excavation and masonry	$492	12.82
Lumber	500	13.03
Millwork and glass	906	23.61
Carpenter labor	758	19.75
Plastering	234	6.09
Hardware	77	2.01
Tin	65	1.70
Painting	280	7.30
Heating and mantel	200	5.22
Plumbing	325	8.47
	$3,837	100.0

For sod around buildings the charge in Omaha is 12c per sq yd laid.

* * * * * *

No matter how well you build your house it will not satisfy everyone. There are many different tastes, and it is well that there are. In "The Canadian Architect and Builder," for June, 1902, there it a pleasant little article which may be read with profit:

MISTAKES IN HIS NEW HOUSE.

O. M. Weand, a railroad contractor, of Reading, Pa., has just finished building a house for himself and to commemorate the event, has published an illustrated pamphlet of fifty or more pages containing the criticisms of leading citizens. The title of the book is "The Mistakes I Made in Building a House." Following are some of the criticisms of his friends:

"Of course, you are building the house, but if it were mine, I would run an open porch around the corner so as to connect the two porches."

"I would prefer one large window in the second-story front, instead of the double window."

"You'll make a mistake if you don't pebble dash the exterior."

"You better run the 13-inch walls all the way up. It gets pretty windy out here sometimes."

"I think the ceilings are too low."

"My! How small the rooms are."

"You ought to be on the other side of the street."

"If it were my house, I would prefer to have the cornice several inches higher."

"By all means put a double line of boards on the first floor. It keeps the cellar dust from coming through."

"Those chimney tops look like tomb-stones."

"The lawn steps should have been immediately in front of the main entrance."

"Why didn't you set the house in the middle of the lot?"

"Personally, I prefer steam heat to the hot water system."

PRESS NOTICES, TESTIMONIALS, ETC.
Of First Edition.

The principal Appraisal Company of the United States after examining one book bought twenty-six for its estimators in various large cities; three other Appraisal Companies use it; it is used on nearly all railroads in the United States; the "Engineering News" bought more than a score for its customers; in April and May, 1905, orders came from the libraries of Pittsburg, Chicago, Milwaukee, Boston, St. Louis, Cleveland, Astor, N. Y.; and contractors and insurance companies have swelled the list of purchasers.

"One of the most valuable books it has been the lot of the editor to examine is 'The Building Estimator.' * * * He has compiled a work which ought to be in the hands of every carpenter and contractor, and on the desk of every estimator in every architect's office in the country. Mechanical engineers have Kent, civil engineers have Trautwine, architects use Kidder's, and contractors should use Arthur's." —*Architects and Builders Journal*, Baltimore, Aug., 1904.

"The author has succeeded in crowding a great deal of valuable cost data in a small space. Some twelve buildings erected by the author are illustrated in order to give a general idea of the classes of construction upon which prices are given. * * * Abbreviations are not always clear, such as ci for cubic inches. In spite of certain defects the book appears to be the most complete of its class yet published." —*Engineering News*, New York, Aug. 18, 1904.

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